



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 10, 2024 – 06:07 PM EST

PDB ID : 2MIN  
Title : NITROGENASE MOFE PROTEIN FROM AZOTOBACTER VINELANDII,  
OXIDIZED STATE  
Authors : Peters, J.W.; Stowell, M.H.B.; Soltis, S.M.; Day, M.W.; Kim, J.; Rees, D.C.  
Deposited on : 1996-12-20  
Resolution : 2.03 Å(reported)

This is a wwPDB X-ray Structure Validation Summary 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 : 1.8.5 (274361), CSD as541be (2020)  
Xtrriage (Phenix) : **NOT EXECUTED**  
EDS : **NOT EXECUTED**  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.36

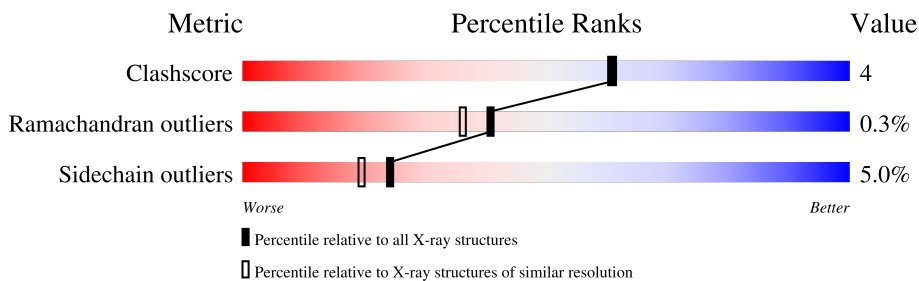
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 2.03 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	11643 (2.04-2.00)
Ramachandran outliers	138981	11493 (2.04-2.00)
Sidechain outliers	138945	11492 (2.04-2.00)

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  $\geq 3$ , 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  $\leq 5\%$ .

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	491	
1	C	491	
2	B	522	
2	D	522	

The following table lists non-polymeric compounds, carbohydrate monomers and non-standard residues in protein, DNA, RNA chains that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Chirality	Geometry	Clashes	Electron density
5	CFM	C	496	-	-	X	-

## 2 Entry composition [i](#)

There are 7 unique types of molecules in this entry. The entry contains 16491 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.

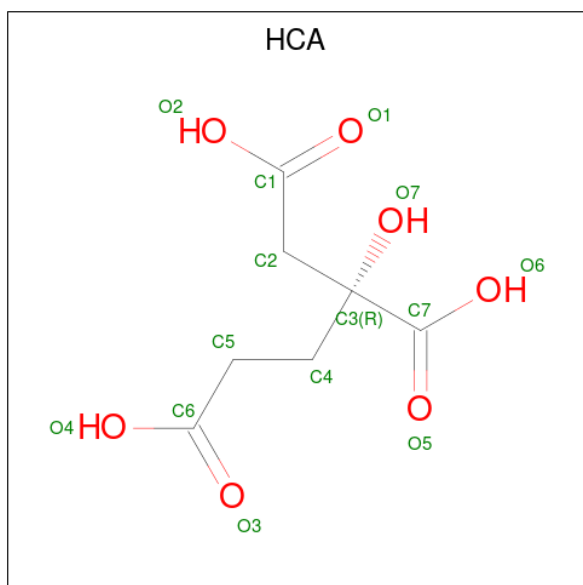
- Molecule 1 is a protein called NITROGENASE MOLYBDENUM IRON PROTEIN.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	467	Total 3709	C 2361	N 630	O 694	S 24	0	0	0
1	C	468	Total 3713	C 2364	N 631	O 694	S 24	0	0	0

- Molecule 2 is a protein called NITROGENASE MOLYBDENUM IRON PROTEIN.

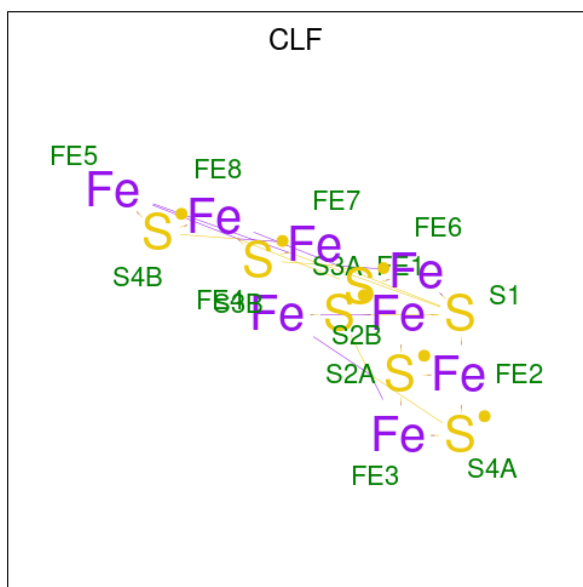
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
2	B	522	Total 4174	C 2666	N 705	O 775	S 28	0	0	0
2	D	522	Total 4174	C 2666	N 705	O 775	S 28	0	0	0

- Molecule 3 is 3-HYDROXY-3-CARBOXY-ADIPIC ACID (three-letter code: HCA) (formula:  $C_7H_{10}O_7$ ).



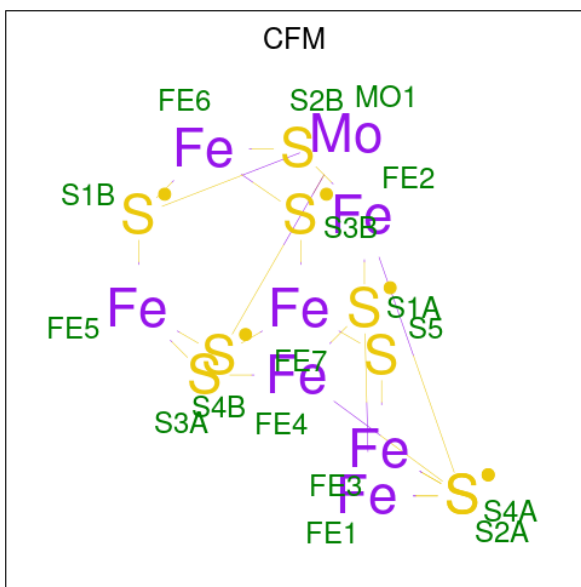
Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
3	A	1	Total C O 14 7 7	0	0
3	C	1	Total C O 14 7 7	0	0

- Molecule 4 is FE(8)-S(7) CLUSTER (three-letter code: CLF) (formula: Fe<sub>8</sub>S<sub>7</sub>).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
4	A	1	Total Fe S 15 8 7	0	0
4	C	1	Total Fe S 15 8 7	0	0

- Molecule 5 is FE-MO-S CLUSTER (three-letter code: CFM) (formula: Fe<sub>7</sub>MoS<sub>9</sub>).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	A	1	Total	Fe	Mo	S	0	0
			17	7	1	9		
5	C	1	Total	Fe	Mo	S	0	0
			17	7	1	9		

- Molecule 6 is CALCIUM ION (three-letter code: CA) (formula: Ca).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	B	2	Total	Ca	0	0
			2	2		

- Molecule 7 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
7	A	132	Total	O	0	0
			132	132		
7	B	186	Total	O	0	0
			186	186		
7	C	126	Total	O	0	0
			126	126		
7	D	183	Total	O	0	0
			183	183		







## 4 Data and refinement statistics

Xtrriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 1 21 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	107.70Å 130.20Å 81.30Å 90.00° 110.80° 90.00°	Depositor
Resolution (Å)	30.00 – 2.03	Depositor
% Data completeness (in resolution range)	91.6 (30.00-2.03)	Depositor
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
Refinement program	X-PLOR 3.0	Depositor
R, $R_{free}$	0.212 , 0.266	Depositor
Estimated twinning fraction	No twinning to report.	Xtrriage
Total number of atoms	16491	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	24.0	wwPDB-VP

## 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: CFM, CA, CLF, HCA

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	0.75	2/3795 (0.1%)	1.46	61/5117 (1.2%)
1	C	0.76	3/3799 (0.1%)	1.43	61/5123 (1.2%)
2	B	0.76	2/4280 (0.0%)	1.35	56/5786 (1.0%)
2	D	0.76	2/4280 (0.0%)	1.33	51/5786 (0.9%)
All	All	0.76	9/16154 (0.1%)	1.39	229/21812 (1.0%)

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	A	0	1
1	C	0	1
All	All	0	2

The worst 5 of 9 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	D	188	SER	CB-OG	-14.21	1.23	1.42
2	B	188	SER	CB-OG	-10.66	1.28	1.42
1	A	88	CYS	CB-SG	-7.35	1.69	1.82
2	D	70	CYS	CB-SG	-6.43	1.71	1.82
2	B	153	CYS	CB-SG	-6.40	1.71	1.82

The worst 5 of 229 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	210	ARG	NE-CZ-NH1	11.93	126.26	120.30
2	D	431	ARG	NE-CZ-NH2	-11.88	114.36	120.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	523	ARG	NE-CZ-NH1	11.68	126.14	120.30
2	B	431	ARG	NE-CZ-NH1	11.64	126.12	120.30
2	D	431	ARG	NE-CZ-NH1	11.54	126.07	120.30

There are no chirality outliers.

All (2) planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	446	TYR	Sidechain
1	C	446	TYR	Sidechain

## 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	3709	0	3636	38	0
1	C	3713	0	3638	43	0
2	B	4174	0	4087	42	0
2	D	4174	0	4087	34	0
3	A	14	0	6	0	0
3	C	14	0	6	1	0
4	A	15	0	0	1	0
4	C	15	0	0	1	0
5	A	17	0	0	1	0
5	C	17	0	0	5	0
6	B	2	0	0	0	0
7	A	132	0	0	2	0
7	B	186	0	0	3	0
7	C	126	0	0	3	0
7	D	183	0	0	1	0
All	All	16491	0	15460	141	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 4.

The worst 5 of 141 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)
2:B:209:THR:HG21	2:B:309:TRP:HE1	1.37	0.87
2:B:85:THR:HG22	2:B:146:MET:HB3	1.63	0.80
2:B:346:LYS:HE3	2:D:264:PRO:HG3	1.67	0.75
2:B:499:ASN:HD21	2:D:477:HIS:H	1.38	0.72
2:B:209:THR:HG21	2:B:309:TRP:NE1	2.03	0.72

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	463/491 (94%)	439 (95%)	22 (5%)	2 (0%)	34 28
1	C	464/491 (94%)	441 (95%)	21 (4%)	2 (0%)	34 28
2	B	520/522 (100%)	508 (98%)	11 (2%)	1 (0%)	47 43
2	D	520/522 (100%)	507 (98%)	12 (2%)	1 (0%)	47 43
All	All	1967/2026 (97%)	1895 (96%)	66 (3%)	6 (0%)	41 36

5 of 6 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	6	ARG
2	D	255	SER
2	B	255	SER
1	C	254	SER
1	A	478	PRO

### 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	397/414 (96%)	371 (94%)	26 (6%)	17	11
1	C	396/414 (96%)	369 (93%)	27 (7%)	16	10
2	B	454/454 (100%)	438 (96%)	16 (4%)	36	34
2	D	454/454 (100%)	438 (96%)	16 (4%)	36	34
All	All	1701/1736 (98%)	1616 (95%)	85 (5%)	24	19

5 of 85 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	C	266	PRO
2	D	50	LYS
1	C	284	ARG
1	C	401	TYR
2	D	177	ASP

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 31 such sidechains are listed below:

Mol	Chain	Res	Type
1	C	252	GLN
2	D	499	ASN
1	C	383	HIS
2	D	518	ASN
2	D	168	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 monosaccharides in this entry.

## 5.6 Ligand geometry

Of 8 ligands modelled in this entry, 2 are monoatomic - leaving 6 for Mogul analysis.

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
3	HCA	A	494	5	13,13,13	3.21	4 (30%)	14,18,18	2.70	7 (50%)
4	CLF	A	498	2,1	0,24,24	-	-	-		
4	CLF	C	498	2,1	0,24,24	-	-	-		
5	CFM	A	496	1,3	0,24,24	-	-	-		
3	HCA	C	494	5	13,13,13	2.95	7 (53%)	14,18,18	2.90	7 (50%)
5	CFM	C	496	1,3	0,24,24	-	-	-		

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
4	CLF	A	498	2,1	-	-	0/12/10/10
3	HCA	C	494	5	-	4/17/17/17	-
3	HCA	A	494	5	-	6/17/17/17	-
4	CLF	C	498	2,1	-	-	0/12/10/10

The worst 5 of 11 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	494	HCA	C3-C7	-7.81	1.45	1.53
3	A	494	HCA	C3-C7	-7.63	1.45	1.53
3	A	494	HCA	O5-C7	5.46	1.39	1.22
3	A	494	HCA	O4-C6	-5.11	1.13	1.30
3	C	494	HCA	O5-C7	4.62	1.37	1.22

The worst 5 of 14 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	494	HCA	O5-C7-C3	-6.52	113.02	122.25
3	A	494	HCA	O5-C7-C3	-5.93	113.85	122.25
3	C	494	HCA	O6-C7-C3	5.88	123.26	113.05
3	A	494	HCA	O6-C7-C3	5.29	122.23	113.05
3	C	494	HCA	C3-C2-C1	3.23	121.63	113.81

There are no chirality outliers.

5 of 10 torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	494	HCA	C2-C3-C4-C5
3	A	494	HCA	O7-C3-C4-C5
3	C	494	HCA	C2-C3-C4-C5
3	C	494	HCA	C7-C3-C4-C5
3	C	494	HCA	O7-C3-C4-C5

There are no ring outliers.

5 monomers are involved in 8 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
4	A	498	CLF	1	0
4	C	498	CLF	1	0
5	A	496	CFM	1	0
3	C	494	HCA	1	0
5	C	496	CFM	5	0

## 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

EDS was not executed - this section is therefore empty.

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

EDS was not executed - this section is therefore empty.

### 6.3 Carbohydrates

EDS was not executed - this section is therefore empty.

### 6.4 Ligands

EDS was not executed - this section is therefore empty.

### 6.5 Other polymers

EDS was not executed - this section is therefore empty.