wwPDB X-ray Structure Validation Summary Report (i)

Jan 31, 2016 – 10:13 PM GMT

PDB ID	:	1SMJ
Title	:	Structure of the A264E mutant of cytochrome P450 BM3 complexed with palmitoleate
Authors	:	Joyce, M.G.; Girvan, H.M.; Munro, A.W.; Leys, D.
Deposited on	:	2004-03-09
Resolution	:	2.75 Å(reported)

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

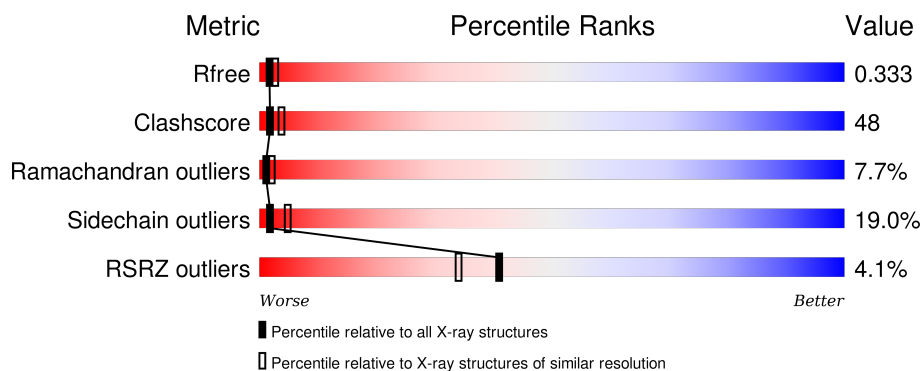|		
MolProbity	:	4.02b-467
Mogul	:	1.7 (RC4), CSD as536be (2015)
Xtriage (Phenix)	:	1.9-1692
EDS	:	rb-20026688
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
Refmac	:	5.8.0135
CCP4	:	6.5.0
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	trunk26865

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 2.75 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		0.333
Clashscore		48
Ramachandran outliers		7.7%
Sidechain outliers		19.0%
RSRZ outliers		4.1%

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}	91344	3340 (2.80-2.72)
Clashscore	102246	3829 (2.80-2.72)
Ramachandran outliers	100387	3767 (2.80-2.72)
Sidechain outliers	100360	3770 (2.80-2.72)
RSRZ outliers	91569	3352 (2.80-2.72)

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 on the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. 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	471	% — 34% · 44% · 16% · ·
1	B	471	5% — 26% · 49% · 18% · ·
1	C	471	6% — 23% · 49% · 20% · 5% ·
1	D	471	4% — 28% · 46% · 20% · ·

2 Entry composition (i)

There are 3 unique types of molecules in this entry. The entry contains 14913 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 Bifunctional P-450:NADPH-P450 reductase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	455	Total	C	N	O	S	0	0	0
			3662	2340	621	684	17			
1	B	455	Total	C	N	O	S	0	0	0
			3670	2344	622	687	17			
1	C	455	Total	C	N	O	S	0	0	0
			3670	2344	622	687	17			
1	D	454	Total	C	N	O	S	0	0	0
			3667	2343	622	685	17			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	264	GLU	ALA	ENGINEERED	UNP P14779
B	264	GLU	ALA	ENGINEERED	UNP P14779
C	264	GLU	ALA	ENGINEERED	UNP P14779
D	264	GLU	ALA	ENGINEERED	UNP P14779

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

HEM

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

- Molecule 3 is PALMITOLEIC ACID (three-letter code: PAM) (formula: $C_{16}H_{30}O_2$).

PAM

Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total 18	C 16	O 2	0	0
3	B	1	Total 18	C 16	O 2	0	0
3	C	1	Total 18	C 16	O 2	0	0
3	D	1	Total 18	C 16	O 2	0	0

3 Residue-property plots ⓘ

These plots are drawn for all protein, RNA and DNA chains in the entry. The first graphic for a chain summarises the proportions of errors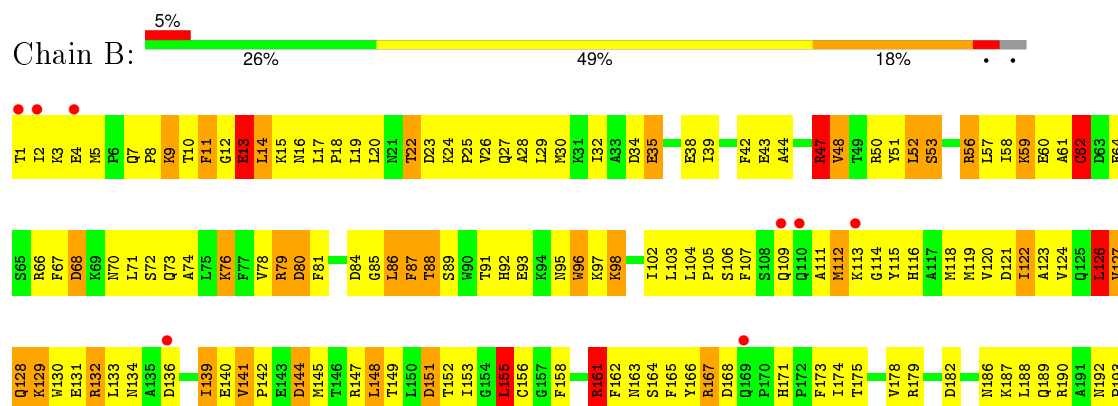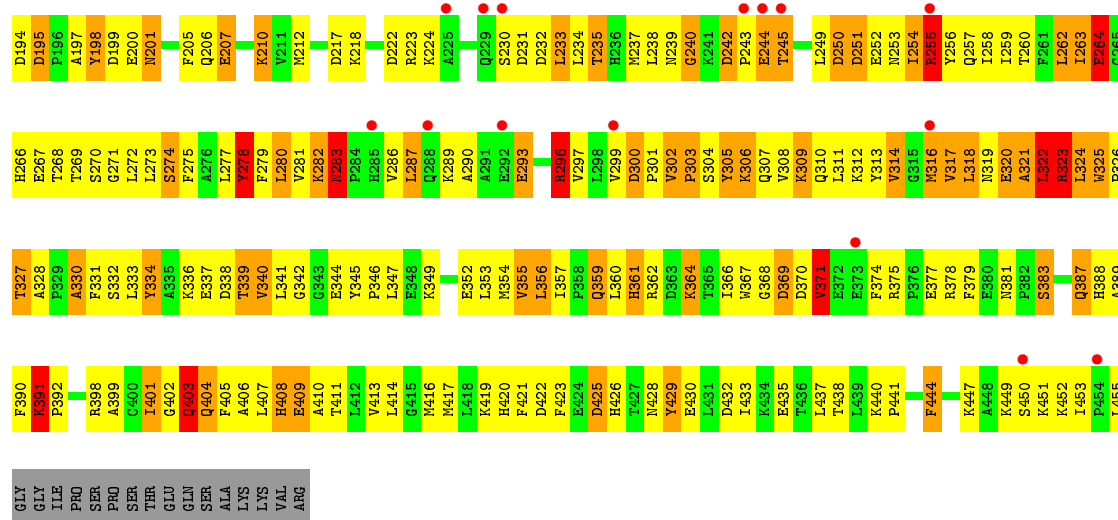 displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or 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: Bifunctional P-450:NADPH-P450 reductase

- Molecule 1: Bifunctional P-450:NADPH-P450 reductase

• Molecule 1: Bifunctional P-450:NADPH-P450 reductase

Chain C:

• Molecule 1: Bifunctional P-450:NADPH-P450 reductase

Chain D:

4 Data and refinement statistics (i)

Property	Value	Source
Space group	C 2 2 21	Depositor
Cell constants a, b, c, α, β, γ	107.31Å 166.89Å 224.94Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	15.00 – 2.75 15.00 – 2.75	Depositor EDS
% Data completeness (in resolution range)	100.0 (15.00-2.75) 99.1 (15.00-2.75)	Depositor EDS
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
$< I/\sigma(I) >$ [1]	2.74 (at 2.77Å)	Xtriage
Refinement program	REFMAC 5.1	Depositor
R, R_{free}	0.253 , 0.338 0.244 , 0.333	Depositor DCC
R_{free} test set	2645 reflections (5.37%)	DCC
Wilson B-factor (Å^2)	64.3	Xtriage
Anisotropy	0.117	Xtriage
Bulk solvent k_{sol}(e/Å^3), B_{sol}(Å^2)	0.31 , 57.8	EDS
Estimated twinning fraction	No twinning to report.	Xtriage
L-test for twinning[2]	$< |L| > = 0.47, < L^2 > = 0.30$	Xtriage
Outliers	0 of 51908 reflections	Xtriage
F_o,F_c correlation	0.92	EDS
Total number of atoms	14913	wwPDB-VP
Average B, all atoms (Å^2)	56.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 2.78% 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, 0.375 respectively for untwinned datasets, and 0.333, 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: HEM, PAM

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	1.67	36/3747 (1.0%)	1.59	47/5068 (0.9%)
1	B	1.55	23/3755 (0.6%)	1.48	39/5078 (0.8%)
1	C	1.63	38/3755 (1.0%)	1.57	57/5078 (1.1%)
1	D	1.45	14/3752 (0.4%)	1.51	49/5072 (1.0%)
All	All	1.58	111/15009 (0.7%)	1.54	192/20296 (0.9%)

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	3
1	B	0	4
1	C	0	1
All	All	0	8

The worst 5 of 111 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	244	GLU	CD-OE2	13.82	1.40	1.25
1	C	373	GLU	CD-OE2	13.80	1.40	1.25
1	C	373	GLU	CD-OE1	13.44	1.40	1.25
1	B	244	GLU	CD-OE1	12.02	1.38	1.25
1	C	247	GLU	CD-OE2	10.70	1.37	1.25

The worst 5 of 192 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
1	C	23	ASP	CB-CG-OD2	16.00	132.70	118.30

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Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	A	250	ASP	CB-CG-OD2	14.22	131.10	118.30
1	C	23	ASP	CB-CG-OD1	-13.91	105.78	118.30
1	A	322	LEU	CB-CG-CD2	-12.58	89.62	111.00
1	C	351	ASP	CB-CG-OD2	12.05	129.15	118.30

There are no chirality outliers.

5 of 8 planarity outliers are listed below:

Mol	Chain	Res	Type	Group
1	A	283	ASN	Peptide
1	A	292	GLU	Peptide
1	A	341	LEU	Peptide
1	B	283	ASN	Peptide
1	B	303	PRO	Peptide

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	3662	0	3625	312	2
1	B	3670	0	3635	359	1
1	C	3670	0	3636	393	1
1	D	3667	0	3636	337	0
2	A	43	0	30	14	0
2	B	43	0	30	15	0
2	C	43	0	30	4	0
2	D	43	0	30	13	0
3	A	18	0	29	3	0
3	B	18	0	29	0	0
3	C	18	0	29	6	0
3	D	18	0	29	2	0
All	All	14913	0	14768	1423	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 48.

The worst 5 of 1423 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:C:107:PHE:CD2	1:C:401:ILE:HG22	1.45	1.49
1:C:85:GLY:HA2	1:C:257:GLN:NE2	1.50	1.24
1:C:100:HIS:CE1	1:C:104:LEU:HD22	1.72	1.22
1:B:313:TYR:HA	1:B:316:MET:CE	1.71	1.20
1:B:281:VAL:CG1	1:B:425:ASP:HB2	1.71	1.20

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:250:ASP:OD2	1:C:23:ASP:OD2[2_664]	1.70	0.50
1:A:207:GLU:OE2	1:B:207:GLU:OE2[6_664]	2.04	0.16

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	453/471 (96%)	358 (79%)	66 (15%)	29 (6%)	2	3
1	B	453/471 (96%)	326 (72%)	89 (20%)	38 (8%)	1	2
1	C	453/471 (96%)	307 (68%)	102 (22%)	44 (10%)	1	1
1	D	452/471 (96%)	351 (78%)	72 (16%)	29 (6%)	2	3
All	All	1811/1884 (96%)	1342 (74%)	329 (18%)	140 (8%)	1	2

5 of 140 Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	342	GLY
1	A	365	THR
1	A	377	GLU
1	A	425	ASP
1	A	452	LYS

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	397/413 (96%)	327 (82%)	70 (18%)	2	6
1	B	399/413 (97%)	320 (80%)	79 (20%)	1	4
1	C	399/413 (97%)	327 (82%)	72 (18%)	2	5
1	D	399/413 (97%)	317 (79%)	82 (21%)	1	3
All	All	1594/1652 (96%)	1291 (81%)	303 (19%)	2	5

5 of 303 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	371	VAL
1	C	134	ASN
1	D	338	ASP
1	B	401	ILE
1	C	39	ILE

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. 5 of 57 such sidechains are listed below:

Mol	Chain	Res	Type
1	B	239	ASN
1	B	420	HIS
1	D	239	ASN
1	B	266	HIS
1	B	310	GLN

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 (i)

There are no carbohydrates in this entry.

5.6 Ligand geometry (i)

8 ligands are 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	#$|Z| > 2$
3	PAM	A	1465	-	14,17,17	1.10	1 (7%)	14,17,17	1.18	1 (7%)
2	HEM	A	472	1	30,50,50	2.22	8 (26%)	24,82,82	3.68	13 (54%)
3	PAM	B	2465	-	14,17,17	1.13	1 (7%)	14,17,17	1.14	0
2	HEM	B	472	1	30,50,50	2.08	10 (33%)	24,82,82	3.28	13 (54%)
3	PAM	C	3465	-	14,17,17	1.21	1 (7%)	14,17,17	1.29	2 (14%)
2	HEM	C	472	1	30,50,50	2.52	9 (30%)	24,82,82	4.37	18 (75%)
3	PAM	D	4465	-	14,17,17	1.19	1 (7%)	14,17,17	1.18	1 (7%)
2	HEM	D	472	1	30,50,50	2.15	11 (36%)	24,82,82	2.94	12 (50%)

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
3	PAM	A	1465	-	-	0/13/15/15	0/0/0/0
2	HEM	A	472	1	-	0/10/54/54	0/0/8/8
3	PAM	B	2465	-	-	0/13/15/15	0/0/0/0
2	HEM	B	472	1	-	0/10/54/54	0/0/8/8
3	PAM	C	3465	-	-	0/13/15/15	0/0/0/0
2	HEM	C	472	1	-	0/10/54/54	0/0/8/8
3	PAM	D	4465	-	-	0/13/15/15	0/0/0/0
2	HEM	D	472	1	-	0/10/54/54	0/0/8/8

The worst 5 of 42 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	472	HEM	C3B-C4B	-7.73	1.45	1.51
2	A	472	HEM	C3B-C4B	-7.38	1.45	1.51
2	C	472	HEM	C2C-C1C	-6.27	1.40	1.52
2	B	472	HEM	C1A-CHA	-4.91	1.26	1.39
2	C	472	HEM	C3D-C4D	-4.85	1.45	1.51

The worst 5 of 60 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
2	A	472	HEM	C3B-CAB-CBB	-10.96	107.65	124.46
2	C	472	HEM	C3B-CAB-CBB	-10.73	108.00	124.46
2	C	472	HEM	C4B-CHC-C1C	-7.48	113.32	125.82
2	A	472	HEM	CAA-CBA-CGA	-6.38	101.05	112.75
2	C	472	HEM	CAA-CBA-CGA	-6.27	101.26	112.75

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

7 monomers are involved in 57 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	1465	PAM	3	0
2	A	472	HEM	14	0
2	B	472	HEM	15	0
3	C	3465	PAM	6	0
2	C	472	HEM	4	0
3	D	4465	PAM	2	0
2	D	472	HEM	13	0

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 (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	455/471 (96%)	-0.12	7 (1%)	76	72	24, 46, 66, 87	0
1	B	455/471 (96%)	0.20	23 (5%)	32	24	31, 58, 83, 96	0
1	C	455/471 (96%)	0.22	26 (5%)	27	21	32, 58, 80, 90	0
1	D	454/471 (96%)	0.26	19 (4%)	40	33	38, 62, 80, 92	0
All	All	1819/1884 (96%)	0.14	75 (4%)	41	34	24, 56, 80, 96	0

The worst 5 of 75 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	B	1	THR	7.0
1	C	1	THR	6.7
1	B	229	GLN	5.7
1	D	2	ILE	5.3
1	A	227	GLY	4.7

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 carbohydrates 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. LLDF column lists the quality of electron density of the group with respect to its neighbouring residues in protein, DNA or RNA chains. 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	LLDF	B-factors($Å^2$)	Q<0.9
3	PAM	B	2465	18/18	0.90	0.20	1.97	57,68,74,76	0
3	PAM	D	4465	18/18	0.91	0.22	1.93	45,59,78,79	0
3	PAM	C	3465	18/18	0.92	0.20	0.97	43,50,71,73	0
3	PAM	A	1465	18/18	0.93	0.15	0.76	30,45,62,64	0
2	HEM	A	472	43/43	0.98	0.13	-0.20	18,27,38,43	0
2	HEM	C	472	43/43	0.97	0.14	-0.73	23,30,48,54	0
2	HEM	B	472	43/43	0.97	0.14	-0.74	27,35,59,68	0
2	HEM	D	472	43/43	0.97	0.14	-1.04	29,40,55,60	0

6.5 Other polymers (i)

There are no such residues in this entry.