



Full wwPDB X-ray Structure Validation Report ⓘ

Mar 9, 2026 – 05:00 AM UTC

PDB ID : 5CM8 / pdb_00005cm8
Title : Structural Basis for the Selectivity of Guanine Nucleotide Exchange Factors
for the small G-protein Ral
Authors : Popovic, M.; Schouten, A.; Rehmann, H.
Deposited on : 2015-07-16
Resolution : 2.60 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
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

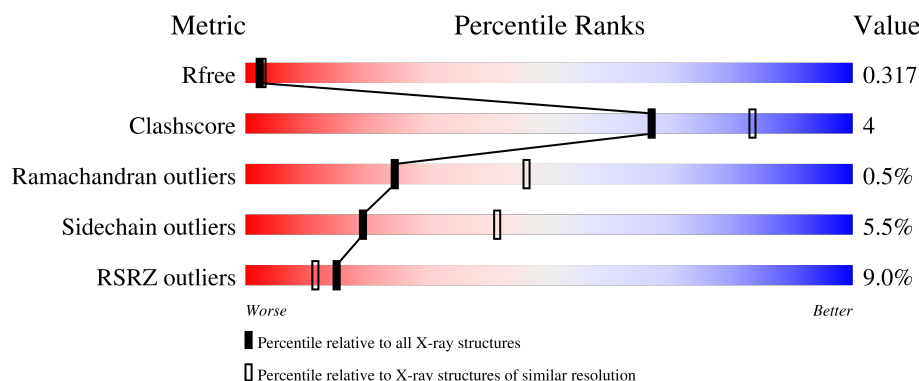
1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

X-RAY DIFFRACTION

The reported resolution of this entry is 2.60 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))
R_{free}	180053	4008 (2.60-2.60)
Clashscore	190562	4347 (2.60-2.60)
Ramachandran outliers	187476	4277 (2.60-2.60)
Sidechain outliers	187428	4277 (2.60-2.60)
RSRZ outliers	180081	4008 (2.60-2.60)

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	473	
2	B	203	

2 Entry composition

There are 3 unique types of molecules in this entry. The entry contains 4634 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 Ral guanine nucleotide dissociation stimulator-like 2.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	419	Total	C	N	O	S	0	0	0
			3278	2060	594	615	9			

There are 10 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	42	GLY	-	expression tag	UNP Q61193
A	43	PRO	-	expression tag	UNP Q61193
A	44	LEU	-	expression tag	UNP Q61193
A	45	GLY	-	expression tag	UNP Q61193
A	46	SER	-	expression tag	UNP Q61193
A	47	PRO	-	expression tag	UNP Q61193
A	48	ASN	-	expression tag	UNP Q61193
A	49	SER	-	expression tag	UNP Q61193
A	147	TYR	HIS	conflict	UNP Q61193
A	402	THR	MET	conflict	UNP Q61193

- Molecule 2 is a protein called Ras-related protein Ral-a.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	169	Total	C	N	O	S	0	0	0
			1311	825	223	258	5			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
B	-1	GLY	-	expression tag	UNP P48555
B	0	SER	-	expression tag	UNP P48555

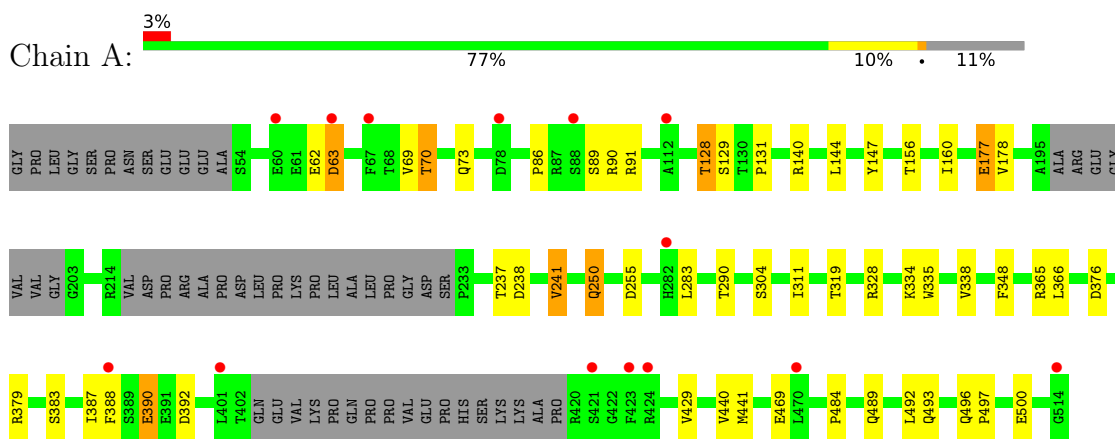
- Molecule 3 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
3	A	39	Total 39	O 39	0	0
3	B	6	Total 6	O 6	0	0

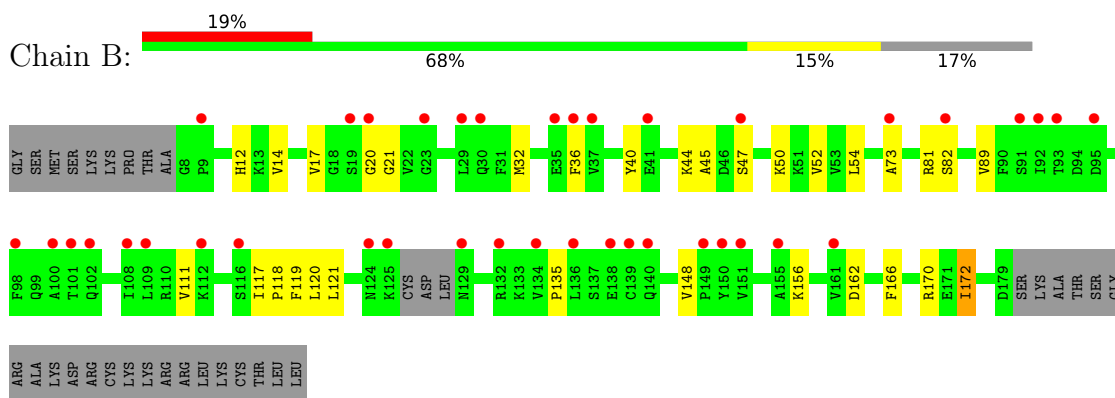
3 Residue-property plots [i](#)

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 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: Ral guanine nucleotide dissociation stimulator-like 2



- Molecule 2: Ras-related protein Ral-a



4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, α , β , γ	111.11Å 98.49Å 71.32Å 90.00° 91.61° 90.00°	Depositor
Resolution (Å)	44.42 – 2.60 44.42 – 2.60	Depositor EDS
% Data completeness (in resolution range)	100.0 (44.42-2.60) 97.7 (44.42-2.60)	Depositor EDS
R_{merge}	0.10	Depositor
R_{sym}	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ ¹	3.35 (at 2.61Å)	Xtriage
Refinement program	REFMAC 5.5.0109	Depositor
R, R_{free}	0.259 , 0.322 0.254 , 0.317	Depositor DCC
R_{free} test set	1159 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å ²)	54.9	Xtriage
Anisotropy	0.437	Xtriage
Bulk solvent k_{sol} (e/Å ³), B_{sol} (Å ²)	0.32 , 25.3	EDS
L-test for twinning ²	$\langle L \rangle = 0.49$, $\langle L^2 \rangle = 0.32$	Xtriage
Estimated twinning fraction	0.032 for -h,-k,l	Xtriage
F_o, F_c correlation	0.92	EDS
Total number of atoms	4634	wwPDB-VP
Average B, all atoms (Å ²)	64.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.02% 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 [i](#)

5.1 Standard geometry [i](#)

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	0.43	0/3345	0.81	0/4538
2	B	0.43	0/1332	0.77	2/1798 (0.1%)
All	All	0.43	0/4677	0.80	2/6336 (0.0%)

There are no bond length outliers.

All (2) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	135	PRO	N-CA-CB	6.80	110.39	103.25
2	B	73	ALA	N-CA-C	5.38	117.01	111.03

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	3278	0	3269	24	0
2	B	1311	0	1227	12	0
3	A	39	0	0	0	0
3	B	6	0	0	0	0
All	All	4634	0	4496	34	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.

All (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:A:73:GLN:HG2	1:A:86:PRO:HB3	1.78	0.65
1:A:128:THR:HG22	1:A:129:SER:H	1.63	0.63
2:B:12:HIS:ND1	2:B:172:ILE:HD11	2.16	0.60
2:B:81:ARG:HB2	2:B:111:VAL:CG1	2.33	0.58
1:A:348:PHE:HB3	1:A:388:PHE:HZ	1.68	0.57
2:B:81:ARG:HB2	2:B:111:VAL:HG12	1.86	0.56
1:A:255:ASP:HB3	1:A:429:VAL:HG11	1.88	0.56
1:A:376:ASP:OD1	1:A:379:ARG:NH2	2.38	0.52
1:A:250:GLN:HG3	1:A:489:GLN:HE21	1.76	0.51
2:B:119:PHE:HD2	2:B:148:VAL:HG11	1.76	0.51
2:B:117:ILE:HG13	2:B:118:PRO:HD2	1.93	0.50
2:B:54:LEU:HD11	2:B:170:ARG:HG3	1.93	0.49
1:A:334:LYS:O	1:A:338:VAL:HG23	2.13	0.49
2:B:81:ARG:HA	2:B:82:SER:HA	1.60	0.48
1:A:144:LEU:HA	1:A:147:TYR:CD1	2.49	0.48
1:A:311:ILE:HD11	1:A:319:THR:HG23	1.96	0.48
1:A:69:VAL:HG22	1:A:90:ARG:HG3	1.95	0.47
1:A:328:ARG:HD3	1:A:366:LEU:HD13	1.97	0.47
1:A:62:GLU:O	1:A:63:ASP:C	2.58	0.45
1:A:441:MET:HG2	2:B:40:TYR:OH	2.16	0.45
1:A:177:GLU:H	1:A:177:GLU:CD	2.25	0.45
1:A:390:GLU:H	1:A:390:GLU:CD	2.24	0.45
1:A:156:THR:O	1:A:160:ILE:HG12	2.17	0.44
1:A:70:THR:HG23	1:A:89:SER:HB3	1.99	0.44
1:A:304:SER:HB3	1:A:335:TRP:HE1	1.83	0.44
1:A:238:ASP:O	1:A:241:VAL:HG12	2.17	0.44
1:A:250:GLN:OE1	1:A:484:PRO:HA	2.18	0.43
1:A:392:ASP:HB3	2:B:45:ALA:HB1	2.00	0.43
1:A:383:SER:O	1:A:387:ILE:HG12	2.19	0.43
1:A:129:SER:HB2	1:A:131:PRO:HD2	2.01	0.42
2:B:162:ASP:O	2:B:166:PHE:HD1	2.02	0.42
2:B:44:LYS:O	2:B:47:SER:HB2	2.19	0.41
2:B:32:MET:HE2	2:B:50:LYS:HB2	2.04	0.40
1:A:496:GLN:HA	1:A:497:PRO:HD2	1.94	0.40

There are no symmetry-related clashes.

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	411/473 (87%)	401 (98%)	9 (2%)	1 (0%)	43	66
2	B	165/203 (81%)	152 (92%)	11 (7%)	2 (1%)	10	23
All	All	576/676 (85%)	553 (96%)	20 (4%)	3 (0%)	24	46

All (3) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	63	ASP
2	B	21	GLY
2	B	20	GLY

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	355/399 (89%)	337 (95%)	18 (5%)	21	45
2	B	134/178 (75%)	125 (93%)	9 (7%)	15	33
All	All	489/577 (85%)	462 (94%)	27 (6%)	19	41

All (27) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	70	THR
1	A	91	ARG
1	A	128	THR

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Mol	Chain	Res	Type
1	A	140	ARG
1	A	177	GLU
1	A	178	VAL
1	A	237	THR
1	A	241	VAL
1	A	250	GLN
1	A	283	LEU
1	A	290	THR
1	A	365	ARG
1	A	390	GLU
1	A	440	VAL
1	A	469	GLU
1	A	492	LEU
1	A	493	GLN
1	A	500	GLU
2	B	14	VAL
2	B	17	VAL
2	B	36	PHE
2	B	52	VAL
2	B	89	VAL
2	B	120	LEU
2	B	121	LEU
2	B	156	LYS
2	B	172	ILE

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	73	GLN
1	A	103	HIS

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 oligosaccharides in this entry.

5.6 Ligand geometry [i](#)

There are no ligands in this entry.

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

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	419/473 (88%)	0.46	14 (3%) 49 43	36, 54, 76, 84	0
2	B	169/203 (83%)	1.37	39 (23%) 2 1	51, 89, 119, 121	0
All	All	588/676 (86%)	0.72	53 (9%) 15 11	36, 59, 102, 121	0

All (53) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
2	B	91	SER	5.1
2	B	139	CYS	4.5
2	B	129	ASN	4.1
2	B	92	ILE	4.0
2	B	124	ASN	3.3
2	B	140	GLN	3.1
2	B	149	PRO	3.1
2	B	82	SER	3.0
2	B	95	ASP	3.0
1	A	63	ASP	2.9
2	B	134	VAL	2.9
1	A	421	SER	2.9
2	B	155	ALA	2.9
2	B	136	LEU	2.9
2	B	109	LEU	2.8
2	B	100	ALA	2.8
2	B	132	ARG	2.8
1	A	470	LEU	2.8
2	B	23	GLY	2.7
2	B	161	VAL	2.7
2	B	112	LYS	2.6
1	A	67	PHE	2.6
1	A	423	PHE	2.6
2	B	36	PHE	2.6

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Mol	Chain	Res	Type	RSRZ
2	B	102	GLN	2.5
2	B	101	THR	2.5
2	B	37	VAL	2.5
1	A	388	PHE	2.5
2	B	35	GLU	2.5
2	B	29	LEU	2.4
1	A	88	SER	2.4
2	B	151	VAL	2.4
2	B	19	SER	2.4
2	B	41	GLU	2.4
2	B	116	SER	2.4
2	B	93	THR	2.3
2	B	9	PRO	2.3
2	B	108	ILE	2.3
2	B	150	TYR	2.3
1	A	112	ALA	2.3
2	B	20	GLY	2.3
2	B	73	ALA	2.2
1	A	60	GLU	2.2
1	A	424	ARG	2.2
1	A	401	LEU	2.2
1	A	514	GLY	2.2
1	A	78	ASP	2.1
2	B	47	SER	2.1
2	B	30	GLN	2.1
2	B	98	PHE	2.1
1	A	282	HIS	2.1
2	B	138	GLU	2.1
2	B	125	LYS	2.0

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 oligosaccharides in this entry.

6.4 Ligands ⓘ

There are no ligands in this entry.

6.5 Other polymers [i](#)

There are no such residues in this entry.