Full wwPDB NMR Structure Validation Report (i)

Apr 27, 2016 – 02:27 AM BST

PDB ID	:	2M51
Title	:	NMR structure of the SH3 domain of human RAS p21 protein activator (GTPase activating protein) 1
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Deposited on	:	2013-02-12

This is a Full wwPDB NMR Structure Validation Report for a publicly released PDB entry.
We welcome your comments at validation@mail.wwpdb.org
A user guide is available at
http://wwpdb.org/validation/2016/NMRValidationReportHelp
with specific help available everywhere you see the (i) symbol.

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

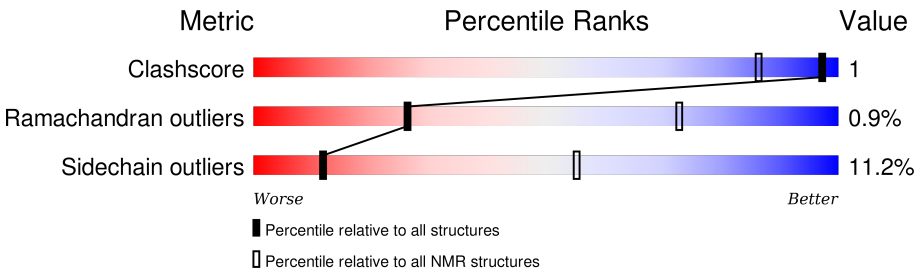
Cyrange	:	Kirchner and Güntert (2011)
NmrClust	:	Kelley et al. (1996)
MolProbity	:	4.02b-467
Mogul	:	unknown
Percentile statistics	:	20151230.v01 (using entries in the PDB archive December 30th 2015)
RCI	:	v_1n_11_5_13_A (Berjanski et al., 2005)
PANAV	:	Wang et al. (2010)
ShiftChecker	:	rb-20027457
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	rb-20027457

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
SOLUTION NMR

The overall completeness of chemical shifts assignment is 83%.

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)	NMR archive (#Entries)
Clashscore	114402	11133
Ramachandran outliers	111179	9975
Sidechain outliers	111093	9958

The table below summarises the geometric issues observed across the polymeric chains and their fit to the experimental data. The red, orange, yellow and green segments indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria. A cyan segment indicates the fraction of residues that are not part of the well-defined cores, and 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%

Mol	Chain	Length	Quality of chain
1	A	62	90% · 6%

2 Ensemble composition and analysis (i)

This entry contains 20 models. Model 5 is the overall representative, medoid model (most similar to other models). The authors have identified model 1 as representative, based on the following criterion: *closest to the average*.

The following residues are included in the computation of the global validation metrics.

Well-defined (core) protein residues			
Well-defined core	**Residue range (total)**	**Backbone RMSD (Å)**	**Medoid model**
1	A:3-A:60 (58)	0.30	5

Ill-defined regions of proteins are excluded from the global statistics.

Ligands and non-protein polymers are included in the analysis.

The models can be grouped into 5 clusters and 4 single-model clusters were found.

Cluster number	Models
1	5, 8, 16, 17
2	3, 9, 11, 12
3	1, 7, 15
4	4, 6, 14
5	10, 19
Single-model clusters	2; 13; 18; 20

3 Entry composition (i)

There is only 1 type of molecule in this entry. The entry contains 1012 atoms, of which 502 are hydrogens and 0 are deuteriums.

- Molecule 1 is a protein called Ras GTPase-activating protein 1.

Mol	Chain	Residues	Atoms						Trace
			Total	C	H	N	O	S	
1	A	62	1012	322	502	89	97	2	0

There is a discrepancy between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	1	GLY	-	leader sequence	UNP P20936

4 Residue-property plots (i)

4.1 Average score per residue in the NMR ensemble

These plots are provided for all protein, RNA and DNA chains in the entry. The first graphic is the same as shown in the summary in section 1 of this report. The second graphic shows the sequence where residues are colour-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 outliers are shown as green connectors. Residues which are classified as ill-defined in the NMR ensemble, are shown in cyan with an underline colour-coded according to the previous scheme. Residues which were present in the experimental sample, but not modelled in the final structure are shown in grey.

- Molecule 1: Ras GTPase-activating protein 1

Chain A:

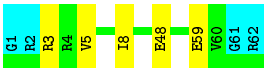
4.2 Scores per residue for each member of the ensemble

Colouring as in section 4.1 above.

4.2.1 Score per residue for model 1

- Molecule 1: Ras GTPase-activating protein 1

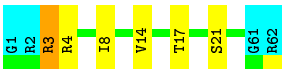
Chain A:



4.2.2 Score per residue for model 2

- Molecule 1: Ras GTPase-activating protein 1

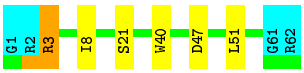
Chain A:



4.2.3 Score per residue for model 3

- Molecule 1: Ras GTPase-activating protein 1

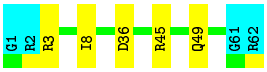
Chain A:



4.2.4 Score per residue for model 4

- Molecule 1: Ras GTPase-activating protein 1

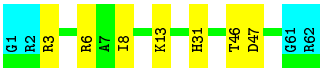
Chain A:



4.2.5 Score per residue for model 5 (medoid)

- Molecule 1: Ras GTPase-activating protein 1

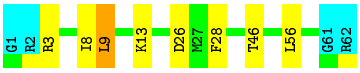
Chain A:



4.2.6 Score per residue for model 6

- Molecule 1: Ras GTPase-activating protein 1

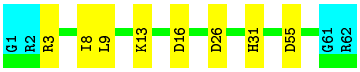
Chain A:



4.2.7 Score per residue for model 7

- Molecule 1: Ras GTPase-activating protein 1

Chain A:



4.2.8 Score per residue for model 8

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 74% 16% • 6%

G1 R2 R3 R4 V5 R6 A7 I8 L9 E19 T20 S21 D26 V30 H31 E59 V60 G61 R62

4.2.9 Score per residue for model 9

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 82% 10% • 6%

G1 R2 R3 R6 A7 I8 D18 D36 R45 E59 V60 G61 R62

4.2.10 Score per residue for model 10

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 68% 23% • 6%

G1 R2 R3 A7 I8 L9 K13 F22 D26 H31 D36 G37 W38 N43 L44 R45 T46 V53 E54 E59 V60 G61 R62

4.2.11 Score per residue for model 11

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 79% 13% • 6%

G1 R2 R3 I8 K13 S21 H31 W40 R45 L51 E59 V60 G61 R62

4.2.12 Score per residue for model 12

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 74% 18% • 6%

G1 R2 R3 R4 V5 I8 L9 V14 T17 S21 M27 H31 W40 L51 E59 V60 G61 R62

4.2.13 Score per residue for model 13

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 84% 10% 6%

4.2.14 Score per residue for model 14

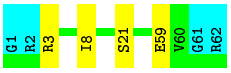
- Molecule 1: Ras GTPase-activating protein 1

Chain A: 77% 15% • 6%

4.2.15 Score per residue for model 15

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 87% 6% 6%



4.2.16 Score per residue for model 16

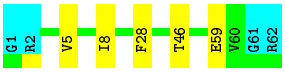
- Molecule 1: Ras GTPase-activating protein 1

Chain A: 82% 10% • 6%

4.2.17 Score per residue for model 17

- Molecule 1: Ras GTPase-activating protein 1

Chain A: 85% 8% 6%



4.2.18 Score per residue for model 18

- Molecule 1: Ras GTPase-activating protein 1

Chain A:

4.2.19 Score per residue for model 19

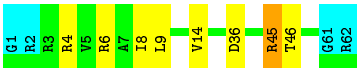
- Molecule 1: Ras GTPase-activating protein 1

Chain A:

4.2.20 Score per residue for model 20

- Molecule 1: Ras GTPase-activating protein 1

Chain A:



5 Refinement protocol and experimental data overview (i)

The models were refined using the following method: *simulated annealing*.

Of the 80 calculated structures, 20 were deposited, based on the following criterion: *target function*.

The following table shows the software used for structure solution, optimisation and refinement.

Software name	Classification	Version
CYANA	structure solution	3.0
j-UNIO	structure solution	
OPAL	refinement	

The following table shows chemical shift validation statistics as aggregates over all chemical shift files. Detailed validation can be found in section 7 of this report.

Chemical shift file(s)	2m51_cs.str
Number of chemical shift lists	1
Total number of shifts	733
Number of shifts mapped to atoms	733
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Assignment completeness (well-defined parts)	83%

No validations of the models with respect to experimental NMR restraints is performed at this time.

6 Model quality (i)

6.1 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 (average) 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	0.58±0.01	0±0/490 (0.0±0.0%)	1.06±0.03	0±1/667 (0.0±0.1%)
All	All	0.58	0/9800 (0.0%)	1.06	6/13340 (0.0%)

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	Planarity
1	A	0.0±0.0	0.8±0.9
All	All	0	17

There are no bond-length outliers.

All unique angle outliers are listed below. They are sorted according to the Z-score of the worst occurrence in the ensemble.

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})	Models	
								Worst	Total
1	A	6	ARG	NE-CZ-NH1	5.94	123.27	120.30	9	1
1	A	3	ARG	NE-CZ-NH2	5.84	123.22	120.30	14	2
1	A	9	LEU	CB-CA-C	5.59	120.83	110.20	6	1
1	A	36	ASP	CB-CG-OD1	5.42	123.18	118.30	9	1
1	A	4	ARG	NE-CZ-NH2	-5.31	117.65	120.30	16	1

There are no chirality outliers.

All unique planar outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Group	Models (Total)
1	A	3	ARG	Sidechain	5
1	A	4	ARG	Sidechain	4
1	A	45	ARG	Sidechain	4

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Mol	Chain	Res	Type	Group	Models (Total)
1	A	6	ARG	Sidechain	3
1	A	11	TYR	Sidechain	1

6.2 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 each 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 averaged over the ensemble.

Mol	Chain	Non-H	H(model)	H(added)	Clashes
1	A	480	470	470	1±1
All	All	9600	9400	9400	17

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 1.

All unique clashes are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Clash(Å)	Distance(Å)	Models	
				Worst	Total
1:A:9:LEU:C	1:A:9:LEU:HD12	0.59	2.18	6	1
1:A:45:ARG:HG3	1:A:46:THR:HG22	0.57	1.77	20	1
1:A:40:TRP:CE3	1:A:51:LEU:HD21	0.53	2.38	3	3
1:A:14:VAL:HG13	1:A:17:THR:HG21	0.53	1.81	12	1
1:A:3:ARG:NH2	1:A:5:VAL:HG13	0.52	2.19	8	1
1:A:14:VAL:CG1	1:A:17:THR:HG21	0.51	2.35	12	1
1:A:40:TRP:CE3	1:A:51:LEU:CD2	0.50	2.95	12	3
1:A:38:TRP:CZ2	1:A:53:VAL:HG13	0.49	2.42	10	1
1:A:7:ALA:HB1	1:A:22:PHE:CE2	0.46	2.45	10	1
1:A:9:LEU:HD11	1:A:56:LEU:HD22	0.45	1.88	6	1
1:A:3:ARG:O	1:A:30:VAL:HG12	0.44	2.12	8	2
1:A:22:PHE:HB2	1:A:43:ASN:HD21	0.41	1.75	18	1

6.3 Torsion angles (i)

6.3.1 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 PDB entries followed by that with respect to all NMR entries. 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	58/62 (94%)	52±2 (90±3%)	5±2 (9±3%)	1±1 (1±1%)	26 73
All	All	1160/1240 (94%)	1042 (90%)	107 (9%)	11 (1%)	26 73

All 2 unique Ramachandran outliers are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	46	THR	6
1	A	36	ASP	5

6.3.2 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 PDB entries followed by that with respect to all NMR entries. 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	54/56 (96%)	48±2 (89±5%)	6±2 (11±5%)	12 55
All	All	1080/1120 (96%)	959 (89%)	121 (11%)	12 55

All 29 unique residues with a non-rotameric sidechain are listed below. They are sorted by the frequency of occurrence in the ensemble.

Mol	Chain	Res	Type	Models (Total)
1	A	8	ILE	20
1	A	3	ARG	15
1	A	59	GLU	10
1	A	21	SER	9
1	A	31	HIS	8
1	A	9	LEU	7
1	A	13	LYS	6
1	A	26	ASP	5
1	A	5	VAL	5
1	A	47	ASP	5
1	A	43	ASN	4
1	A	28	PHE	3
1	A	14	VAL	3
1	A	27	MET	2
1	A	19	GLU	2
1	A	17	THR	2

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Mol	Chain	Res	Type	Models (Total)
1	A	53	VAL	2
1	A	45	ARG	2
1	A	36	ASP	1
1	A	22	PHE	1
1	A	18	ASP	1
1	A	55	ASP	1
1	A	6	ARG	1
1	A	49	GLN	1
1	A	58	GLU	1
1	A	16	ASP	1
1	A	39	MET	1
1	A	54	GLU	1
1	A	48	GLU	1

6.3.3 RNA (i)

There are no RNA molecules in this entry.

6.4 Non-standard residues in protein, DNA, RNA chains (i)

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

6.5 Carbohydrates (i)

There are no carbohydrates in this entry.

6.6 Ligand geometry (i)

There are no ligands in this entry.

6.7 Other polymers (i)

There are no such molecules in this entry.

6.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

7 Chemical shift validation (i)

The completeness of assignment taking into account all chemical shift lists is 83% for the well-defined parts and 80% for the entire structure.

7.1 Chemical shift list 1

File name: 2m51_cs.str

Chemical shift list name: *assigned_chem_shift_list_1*

7.1.1 Bookkeeping (i)

The following table shows the results of parsing the chemical shift list and reports the number of nuclei with statistically unusual chemical shifts.

Total number of shifts	733
Number of shifts mapped to atoms	733
Number of unparsed shifts	0
Number of shifts with mapping errors	0
Number of shifts with mapping warnings	0
Number of shift outliers (ShiftChecker)	6

7.1.2 Chemical shift referencing (i)

The following table shows the suggested chemical shift referencing corrections.

Nucleus	# values	Correction ± precision, *ppm*	Suggested action
$^{13}C_{\alpha}$	60	2.87 ± 0.21	Should be applied
$^{13}C_{\beta}$	56	2.06 ± 0.15	Should be applied
$^{13}C'$	0	—	—
^{15}N	58	1.99 ± 0.79	Should be applied

7.1.3 Completeness of resonance assignments (i)

The following table shows the completeness of the chemical shift assignments for the well-defined regions of the structure. The overall completeness is 83%, i.e. 619 atoms were assigned a chemical shift out of a possible 743. 13 out of 13 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	228/286 (80%)	114/114 (100%)	58/116 (50%)	56/56 (100%)
Sidechain	345/400 (86%)	209/230 (91%)	129/153 (84%)	7/17 (41%)

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	Total	^{1}H	^{13}C	^{15}N
Aromatic	46/57 (81%)	26/30 (87%)	17/24 (71%)	3/3 (100%)
Overall	619/743 (83%)	349/374 (93%)	204/293 (70%)	66/76 (87%)

The following table shows the completeness of the chemical shift assignments for the full structure. The overall completeness is 80%, i.e. 638 atoms were assigned a chemical shift out of a possible 799. 13 out of 13 assigned methyl groups (LEU and VAL) were assigned stereospecifically.

	Total	^{1}H	^{13}C	^{15}N
Backbone	236/306 (77%)	118/122 (97%)	60/124 (48%)	58/60 (97%)
Sidechain	356/436 (82%)	216/252 (86%)	132/161 (82%)	8/23 (35%)
Aromatic	46/57 (81%)	26/30 (87%)	17/24 (71%)	3/3 (100%)
Overall	638/799 (80%)	360/404 (89%)	209/309 (68%)	69/86 (80%)

7.1.4 Statistically unusual chemical shifts (i)

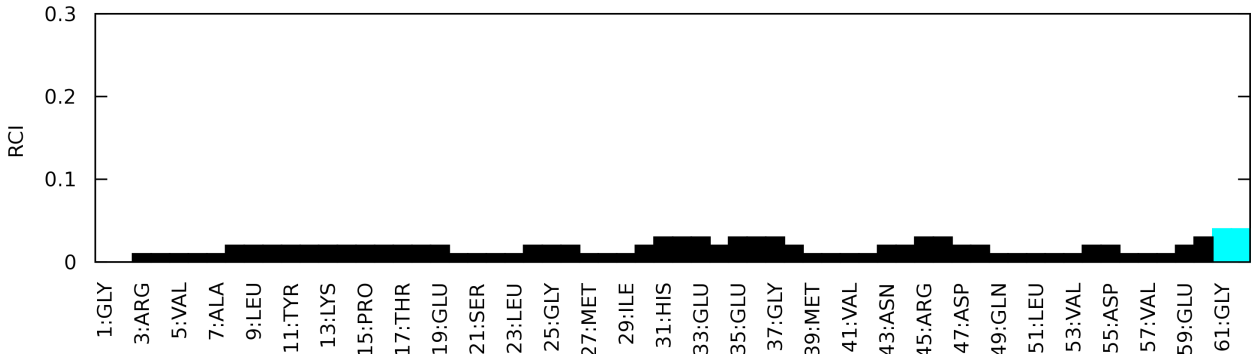
The following table lists the statistically unusual chemical shifts. These are statistical measures, and large deviations from the mean do not necessarily imply incorrect assignments. Molecules containing paramagnetic centres or hemes are expected to give rise to anomalous chemical shifts.

Mol	Chain	Res	Type	Atom	Shift, *ppm*	Expected range, *ppm*	Z-score
1	A	62	ARG	NE	72.34	92.63 – 76.73	-7.8
1	A	11	TYR	HB3	0.67	4.75 – 0.95	-5.8
1	A	53	VAL	HB	0.23	3.59 – 0.39	-5.5
1	A	52	ILE	HD12	-0.83	2.13 – -0.77	-5.2
1	A	52	ILE	HD13	-0.83	2.13 – -0.77	-5.2
1	A	52	ILE	HD11	-0.83	2.13 – -0.77	-5.2

7.1.5 Random Coil Index (RCI) plots (i)

The image below reports *random coil index* values for the protein chains in the structure. The height of each bar gives a probability of a given residue to be disordered, as predicted from the available chemical shifts and the amino acid sequence. A value above 0.2 is an indication of significant predicted disorder. The colour of the bar shows whether the residue is in the well-defined core (black) or in the ill-defined residue ranges (cyan), as described in section 2 on ensemble composition.

Random coil index (RCI) for chain A:


RCI
0.3
0.2
0.1
0
1:GLY
3:ARG
5:VAL
7:ALA
9:LEU
11:TYR
13:LYS
15:PRO
17:THR
19:GLU
21:SER
23:LEU
25:GLY
27:MET
29:ILE
31:HIS
33:GLU
35:GLU
37:GLY
39:MET
41:VAL
43:ASN
45:ARG
47:ASP
49:GLN
51:LEU
53:VAL
55:ASP
57:VAL
59:GLU
61:GLY