



# wwPDB X-ray Structure Validation Summary Report ⓘ

Feb 1, 2016 – 06:33 PM GMT

PDB ID : 4LYH  
Title : Crystal Structure of small molecule vinylsulfonamide 9 covalently bound to K-Ras G12C  
Authors : Ostrem, J.M.; Peters, U.; Sos, M.L.; Wells, J.A.; Shokat, K.M.  
Deposited on : 2013-07-31  
Resolution : 1.37 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  
<http://wwpdb.org/validation/2016/XrayValidationReportHelp>  
with specific help available everywhere you see the ⓘ symbol.

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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 : 1.7 (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

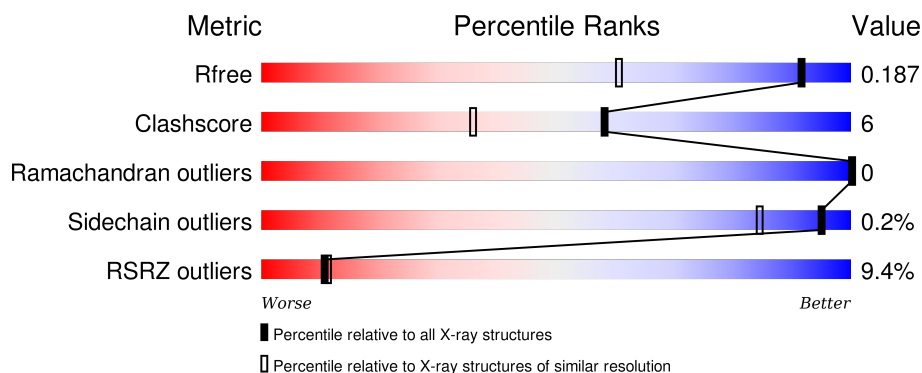
# 1 Overall quality at a glance ⓘ

The following experimental techniques were used to determine the structure:

## *X-RAY DIFFRACTION*

The reported resolution of this entry is 1.37 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))
$R_{free}$	91344	1918 (1.40-1.36)
Clashscore	102246	2042 (1.40-1.36)
Ramachandran outliers	100387	1993 (1.40-1.36)
Sidechain outliers	100360	1992 (1.40-1.36)
RSRZ outliers	91569	1917 (1.40-1.36)

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  $\geq 3$ , 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  $\leq 5\%$ . 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	170	<div> <div>8%</div> <div>88%</div> <div>8%</div> <div>• •</div> </div>
1	B	170	<div> <div>5%</div> <div>82%</div> <div>11%</div> <div>• 6%</div> </div>
1	C	170	<div> <div>14%</div> <div>77%</div> <div>14%</div> <div>• 8%</div> </div>

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
2	SO4	A	201	-	-	-	X
2	SO4	C	201	-	-	X	-
4	21F	C	202	-	-	X	X

## 2 Entry composition

There are 5 unique types of molecules in this entry. The entry contains 8321 atoms, of which 3931 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 GTPase KRas.

Mol	Chain	Residues	Atoms						ZeroOcc	AltConf	Trace
1	A	163	Total	C	H	N	O	S	0	6	0
			2639	830	1317	228	258	6			
1	B	159	Total	C	H	N	O	S	0	5	0
			2604	815	1310	229	245	5			
1	C	156	Total	C	H	N	O	S	0	3	0
			2471	781	1232	219	235	4			

There are 33 discrepancies between the modelled and reference sequences:

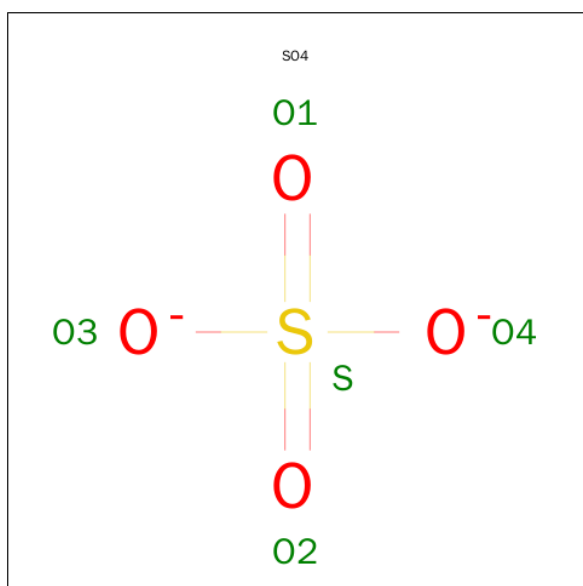
Chain	Residue	Modelled	Actual	Comment	Reference
A	0	GLY	-	EXPRESSION TAG	UNP P01116
A	12	CYS	GLY	VARIANT	UNP P01116
A	51	SER	CYS	ENGINEERED MUTATION	UNP P01116
A	80	LEU	CYS	ENGINEERED MUTATION	UNP P01116
A	118	SER	CYS	ENGINEERED MUTATION	UNP P01116
A	151	GLY	ARG	SEE REMARK 999	UNP P01116
A	153	ASP	GLU	SEE REMARK 999	UNP P01116
A	165	LYS	GLN	SEE REMARK 999	UNP P01116
A	166	HIS	TYR	SEE REMARK 999	UNP P01116
A	167	LYS	ARG	SEE REMARK 999	UNP P01116
A	168	GLU	LEU	SEE REMARK 999	UNP P01116
B	0	GLY	-	EXPRESSION TAG	UNP P01116
B	12	CYS	GLY	VARIANT	UNP P01116
B	51	SER	CYS	ENGINEERED MUTATION	UNP P01116
B	80	LEU	CYS	ENGINEERED MUTATION	UNP P01116
B	118	SER	CYS	ENGINEERED MUTATION	UNP P01116
B	151	GLY	ARG	SEE REMARK 999	UNP P01116
B	153	ASP	GLU	SEE REMARK 999	UNP P01116
B	165	LYS	GLN	SEE REMARK 999	UNP P01116
B	166	HIS	TYR	SEE REMARK 999	UNP P01116
B	167	LYS	ARG	SEE REMARK 999	UNP P01116
B	168	GLU	LEU	SEE REMARK 999	UNP P01116
C	0	GLY	-	EXPRESSION TAG	UNP P01116

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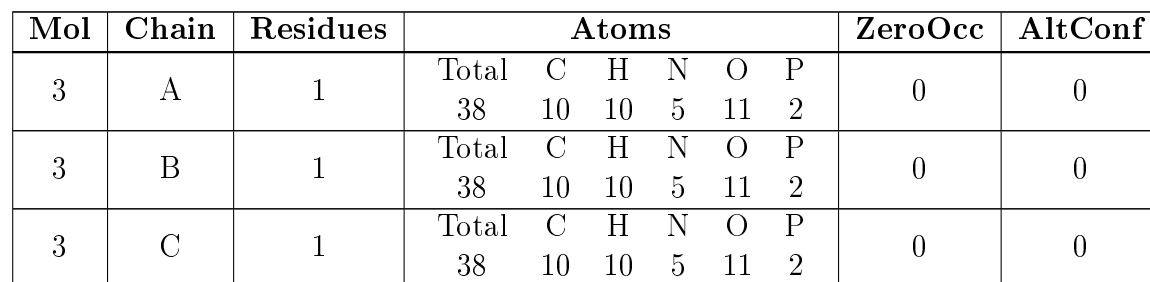
Chain	Residue	Modelled	Actual	Comment	Reference
C	12	CYS	GLY	VARIANT	UNP P01116
C	51	SER	CYS	ENGINEERED MUTATION	UNP P01116
C	80	LEU	CYS	ENGINEERED MUTATION	UNP P01116
C	118	SER	CYS	ENGINEERED MUTATION	UNP P01116
C	151	GLY	ARG	SEE REMARK 999	UNP P01116
C	153	ASP	GLU	SEE REMARK 999	UNP P01116
C	165	LYS	GLN	SEE REMARK 999	UNP P01116
C	166	HIS	TYR	SEE REMARK 999	UNP P01116
C	167	LYS	ARG	SEE REMARK 999	UNP P01116
C	168	GLU	LEU	SEE REMARK 999	UNP P01116

- Molecule 2 is SULFATE ION (three-letter code: SO<sub>4</sub>) (formula: O<sub>4</sub>S).



Mol	Chain	Residues	Atoms	ZeroOcc	AltConf
2	A	1	Total O S 5 4 1	0	0
2	C	1	Total O S 5 4 1	0	0

- Molecule 3 is GUANOSINE-5'-DIPHOSPHATE (three-letter code: GDP) (formula: C<sub>10</sub>H<sub>15</sub>N<sub>5</sub>O<sub>11</sub>P<sub>2</sub>).



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- ORTEP diagram of compound 21F. The structure shows a central benzene ring substituted with a chlorine atom (Cl1), a methoxy group (O03, C003), a nitro group (N07, O05, O06), and a 2-((4-ethylsulfonyl)piperidin-1-yl)acetamido group (N07, O05, O06, C006, C007, C008, C009, C010, C011, C012, C013, C014, C015, C016, C017, O018, O019, O020, O021, O022, O023, O024, O025). The displacement ellipsoids are drawn at the 50% probability level.

Mol	Chain	Residues	Atoms								ZeroOcc	AltConf
4	B	1	Total 48	C 16	Cl 1	H 22	I 1	N 3	O 4	S 1	0	0
4	C	1	Total 46	C 16	Cl 1	H 20	I 1	N 3	O 4	S 1	0	0

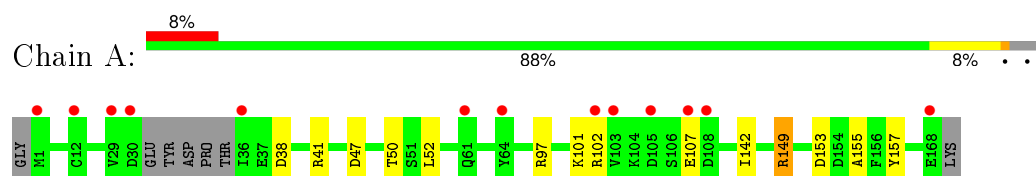
- Molecule 5 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	154	Total 154	O 154	0	0
5	B	142	Total 142	O 142	0	0
5	C	93	Total 93	O 93	0	0

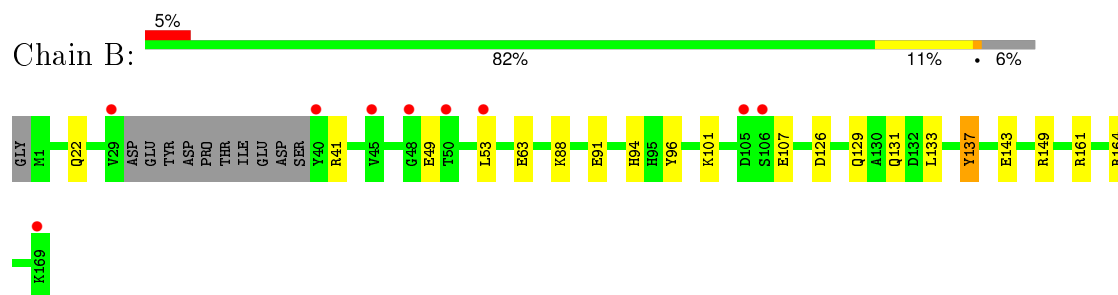
### 3 Residue-property plots [i](#)

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.

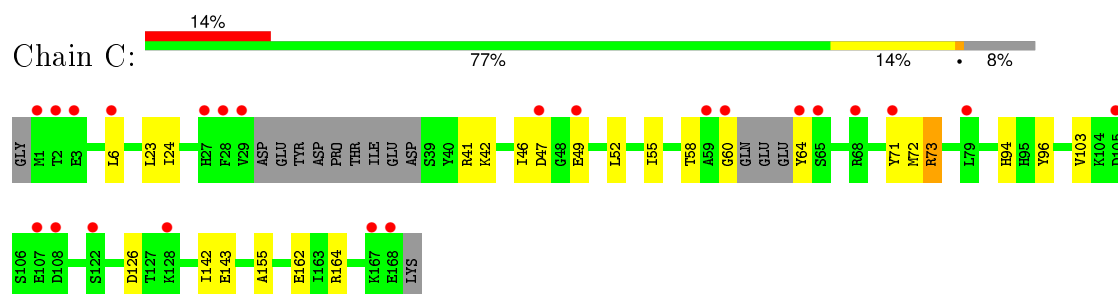
- Molecule 1: GTPase KRas



- Molecule 1: GTPase KRas



- Molecule 1: GTPase KRas





## 4 Data and refinement statistics

Property	Value	Source
Space group	C 1 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	68.03 Å 83.53 Å 86.97 Å 90.00° 111.13° 90.00°	Depositor
Resolution (Å)	19.12 – 1.37 19.12 – 1.37	Depositor EDS
% Data completeness (in resolution range)	99.8 (19.12-1.37) 96.8 (19.12-1.37)	Depositor EDS
$R_{merge}$	0.05	Depositor
$R_{sym}$	0.05	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	3.69 (at 1.37 Å)	Xtriage
Refinement program	PHENIX (phenix.refine: dev_1402)	Depositor
R, $R_{free}$	0.165 , 0.188 0.170 , 0.187	Depositor DCC
$R_{free}$ test set	2007 reflections (2.23%)	DCC
Wilson B-factor (Å <sup>2</sup> )	15.5	Xtriage
Anisotropy	0.084	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.46 , 56.3	EDS
Estimated twinning fraction	0.015 for h,-k,-h-l	Xtriage
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Outliers	0 of 94652 reflections	Xtriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	8321	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	27.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 5.44% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.375 respectively for untwinned datasets, and 0.333, 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: GDP, 21F, SO4

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	0.96	1/1358 (0.1%)	1.08	7/1828 (0.4%)
1	B	0.91	1/1327 (0.1%)	0.91	2/1782 (0.1%)
1	C	0.87	0/1265	0.95	3/1703 (0.2%)
All	All	0.92	2/3950 (0.1%)	0.99	12/5313 (0.2%)

All (2) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	96	TYR	CE2-CZ	-8.57	1.27	1.38
1	A	157	TYR	CE1-CZ	-5.99	1.30	1.38

The worst 5 of 12 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
1	C	73	ARG	NE-CZ-NH1	9.36	124.98	120.30
1	C	73	ARG	NE-CZ-NH2	-8.00	116.30	120.30
1	A	97[A]	ARG	NE-CZ-NH1	7.83	124.22	120.30
1	A	97[B]	ARG	NE-CZ-NH1	7.83	124.22	120.30
1	A	38	ASP	CB-CG-OD1	6.92	124.53	118.30

There are no chirality outliers.

There are no planarity outliers.

### 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	1322	1317	1325	6	1
1	B	1294	1310	1315	11	0
1	C	1239	1232	1241	26	0
2	A	5	0	0	0	0
2	C	5	0	0	5	0
3	A	28	10	12	0	0
3	B	28	10	12	0	0
3	C	28	10	12	0	0
4	B	26	22	22	0	0
4	C	26	20	22	10	0
5	A	154	0	0	2	1
5	B	142	0	0	4	0
5	C	93	0	0	8	0
All	All	4390	3931	3961	47	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 6.

The worst 5 of 47 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:C:201:SO4:O3	2:C:201:SO4:S	0.77	1.16
1:C:94[B]:HIS:ND1	5:C:362:HOH:O	1.88	1.03
2:C:201:SO4:O1	2:C:201:SO4:O3	1.77	1.01
2:C:201:SO4:O4	2:C:201:SO4:O3	1.80	0.96
2:C:201:SO4:O3	2:C:201:SO4:O2	1.86	0.93

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:50:THR:HG1	1:A:50:THR:HG1[2_1059]	1.27	0.33
5:A:427:HOH:O	5:A:429:HOH:O[2_1059]	1.95	0.25

## 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	165/170 (97%)	164 (99%)	1 (1%)	0	100	100
1	B	160/170 (94%)	156 (98%)	4 (2%)	0	100	100
1	C	153/170 (90%)	150 (98%)	3 (2%)	0	100	100
All	All	478/510 (94%)	470 (98%)	8 (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	148/150 (99%)	148 (100%)	0	100	100
1	B	143/150 (95%)	142 (99%)	1 (1%)	88	69
1	C	135/150 (90%)	135 (100%)	0	100	100
All	All	426/450 (95%)	425 (100%)	1 (0%)	95	84

All (1) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	B	88	LYS

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

Mol	Chain	Res	Type
1	A	27	HIS
1	C	99	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 ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry ⓘ

7 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$
2	SO4	A	201	-	4,4,4	0.95	0	6,6,6	0.30	0
3	GDP	A	202	-	23,30,30	1.55	4 (17%)	28,47,47	1.68	4 (14%)
4	21F	B	201	1	25,27,27	1.15	2 (8%)	33,38,38	1.24	4 (12%)
3	GDP	B	202	-	23,30,30	1.70	5 (21%)	28,47,47	1.44	5 (17%)
2	SO4	C	201	-	4,4,4	9.76	1 (25%)	6,6,6	0.58	0
4	21F	C	202	1	25,27,27	1.70	4 (16%)	33,38,38	2.97	12 (36%)
3	GDP	C	203	-	23,30,30	1.45	3 (13%)	28,47,47	1.49	7 (25%)

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
2	SO4	A	201	-	-	0/0/0/0	0/0/0/0
3	GDP	A	202	-	-	0/12/32/32	0/3/3/3

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Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
4	21F	B	201	1	-	0/19/29/29	0/2/2/2
3	GDP	B	202	-	-	0/12/32/32	0/3/3/3
2	SO4	C	201	-	-	0/0/0/0	0/0/0/0
4	21F	C	202	1	-	0/19/29/29	0/2/2/2
3	GDP	C	203	-	-	0/12/32/32	0/3/3/3

The worst 5 of 19 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	C	201	SO4	O3-S	-19.43	0.77	1.47
3	A	202	GDP	C2-N3	-3.78	1.29	1.33
3	C	203	GDP	C6-N1	-3.59	1.31	1.36
3	A	202	GDP	PA-O2A	-2.96	1.42	1.54
4	B	201	21F	C03-I04	-2.95	2.02	2.10

The worst 5 of 32 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
4	C	202	21F	O19-S15-O18	-11.93	98.73	119.34
4	C	202	21F	C08-N07-C06	-5.52	115.23	123.73
3	A	202	GDP	N2-C2-N1	-5.19	112.12	117.80
3	C	203	GDP	C1'-N9-C4	-3.22	122.08	126.94
4	B	201	21F	C08-N07-C06	-3.03	119.06	123.73

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

2 monomers are involved in 15 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
2	C	201	SO4	5	0
4	C	202	21F	10	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, 95<sup>th</sup> 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 <sup>2</sup> )	Q<0.9
1	A	163/170 (95%)	0.46	13 (7%) 15 15	10, 20, 39, 57	0
1	B	159/170 (93%)	0.45	9 (5%) 27 26	11, 21, 41, 52	0
1	C	156/170 (91%)	0.88	23 (14%) 3 3	12, 25, 48, 56	0
All	All	478/510 (93%)	0.59	45 (9%) 11 11	10, 21, 43, 57	0

The worst 5 of 45 RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	C	64	TYR	10.4
1	B	40	TYR	6.6
1	C	2	THR	6.2
1	A	29	VAL	5.7
1	B	29	VAL	5.7

### 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, 95<sup>th</sup> 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( $\text{\AA}^2$ )	Q<0.9
2	SO4	A	201	5/5	0.95	0.25	3.65	33,39,44,53	0
4	21F	C	202	26/26	0.79	0.31	2.98	17,29,87,103	46
2	SO4	C	201	5/5	0.99	0.19	1.26	12,13,49,51	0
3	GDP	C	203	28/28	0.96	0.08	-0.39	14,20,31,36	0
3	GDP	A	202	28/28	0.97	0.07	-0.54	12,17,26,29	0
3	GDP	B	202	28/28	0.98	0.06	-0.73	13,16,22,26	0
4	21F	B	201	26/26	0.97	0.07	-1.02	15,19,24,31	0

## 6.5 Other polymers [i](#)

There are no such residues in this entry.