



# wwPDB X-ray Structure Validation Summary Report

Feb 28, 2014 – 11:06 AM GMT

PDB ID : 3PO4  
Title : Structure of a mutant of the large fragment of DNA polymerase I from *Thermus aquaticus* in complex with a blunt-ended DNA and ddATP  
Authors : Marx, A.; Diederichs, K.; Obeid, S.  
Deposited on : 2010-11-22  
Resolution : 1.80 Å(reported)

This is a wwPDB 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/ValidationPDFNotes.html>

---

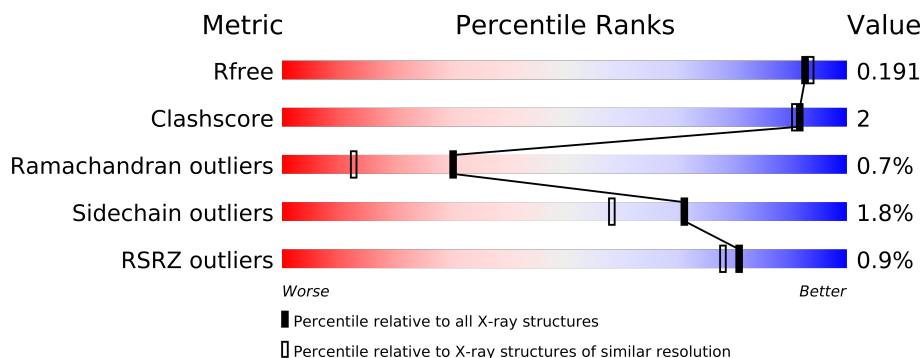
The following versions of software and data (see [references](#)) were used in the production of this report:

MolProbity	:	4.02b-467
Mogul	:	1.15 2013
Xtriage (Phenix)	:	dev-1323
EDS	:	stable22639
Percentile statistics	:	21963
Refmac	:	5.8.0049
CCP4	:	6.3.0 (Settle)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et. al. (1996)
Validation Pipeline (wwPDB-VP)	:	stable22683

# 1 Overall quality at a glance

The reported resolution of this entry is 1.80 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))
$R_{free}$	66092	3513 (1.80-1.80)
Clashscore	79885	4461 (1.80-1.80)
Ramachandran outliers	78287	4404 (1.80-1.80)
Sidechain outliers	78261	4403 (1.80-1.80)
RSRZ outliers	66119	3515 (1.80-1.80)

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. The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density.

Mol	Chain	Length	Quality of chain
1	A	540	
2	B	12	
3	C	12	

The following table lists non-polymeric compounds that are outliers for geometric or electron-density-fit criteria:

Mol	Type	Chain	Res	Geometry	Electron density
4	MG	B	1	-	X
5	NA	A	833	-	X

## 2 Entry composition

There are 8 unique types of molecules in this entry. The entry contains 5385 atoms, of which 0 are hydrogen and 0 are deuterium.

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 DNA polymerase I.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	538	Total	C	N	O	S	0	4	0
			4313	2736	781	784	12			

There are 2 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	614	LYS	ILE	ENGINEERED MUTATION	UNP P19821
A	747	LYS	MET	ENGINEERED MUTATION	UNP P19821

- Molecule 2 is a DNA chain called DNA (5'-D(\*GP\*AP\*CP\*CP\*AP\*CP\*GP\*GP\*CP\*GP\*CP\*(2DA))-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
2	B	12	Total	C	N	O	P	0	0	0
			242	115	50	66	11			

- Molecule 3 is a DNA chain called DNA (5'-D(\*TP\*GP\*CP\*GP\*CP\*CP\*GP\*TP\*GP\*GP\*TP\*C)-3').

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
3	C	12	Total	C	N	O	P	0	0	0
			243	116	43	73	11			

- Molecule 4 is MAGNESIUM ION (three-letter code: MG) (formula: Mg).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	B	2	Total	Mg	0	0
			2	2		
4	A	1	Total	Mg	0	0
			1	1		

- Molecule 5 is SODIUM ION (three-letter code: NA) (formula: Na).

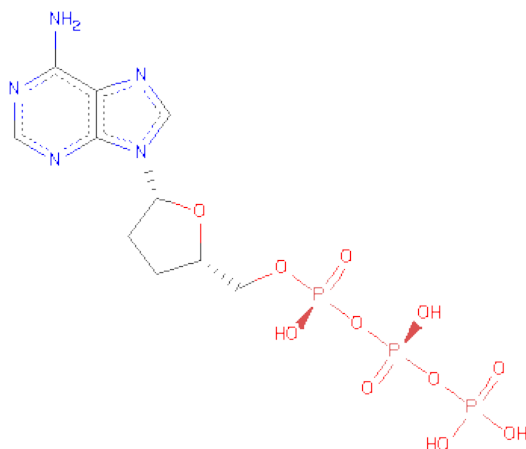
Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
5	A	1	Total	Na	0	0
			1	1		

- Molecule 6 is GLYCEROL (three-letter code: GOL) (formula:  $C_3H_8O_3$ ).



Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
6	A	1	Total	C	O	0	0
			6	3	3		

- Molecule 7 is 2',3'-DIDEOXYADENOSINETRIPHOSPHATE (three-letter code: DDS) (formula:  $C_{10}H_{16}N_5O_{11}P_3$ ).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
7	A	1	Total	C	N	O	P	0	0
			29	10	5	11	3		

- Molecule 8 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
8	A	438	Total	O	0	0
			438	438		
8	B	44	Total	O	0	0
			44	44		
8	C	66	Total	O	0	0
			66	66		

### 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.

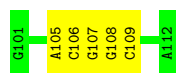
- Molecule 1: DNA polymerase I

Chain A: 



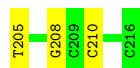
- Molecule 2: DNA (5'-D(\*GP\*AP\*CP\*CP\*AP\*CP\*GP\*GP\*CP\*GP\*CP\*(2DA))-3')

Chain B: 



- Molecule 3: DNA (5'-D(\*TP\*GP\*CP\*GP\*CP\*CP\*GP\*TP\*GP\*GP\*TP\*C)-3')

Chain C: 



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 31 2 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	113.53Å 113.53Å 91.24Å 90.00° 90.00° 120.00°	Depositor
Resolution (Å)	48.20 – 1.80 48.20 – 1.80	Depositor EDS
% Data completeness (in resolution range)	100.0 (48.20-1.80) 100.0 (48.20-1.80)	Depositor EDS
$R_{merge}$	0.07	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	1.44 (at 1.79Å)	Xtriage
Refinement program	PHENIX (PHENIX.REFINE: DEV_572)	Depositor
R, $R_{free}$	0.164 , 0.194 0.161 , 0.191	Depositor DCC
$R_{free}$ test set	3136 reflections (4.97%)	DCC
Wilson B-factor (Å <sup>2</sup> )	33.1	Xtriage
Anisotropy	0.184	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.32 , 37.8	EDS
Estimated twinning fraction	0.032 for -h,-k,l	Xtriage
L-test for twinning	$\langle  L  \rangle = 0.49$ , $\langle L^2 \rangle = 0.32$	Xtriage
Outliers	0 of 63103 reflections	Xtriage
$F_o, F_c$ correlation	0.97	EDS
Total number of atoms	5385	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	40.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 3.25% of the height of the origin peak. No significant pseudotranslation is detected.*

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

## 5 Model quality ⓘ

### 5.1 Standard geometry ⓘ

Bond lengths and bond angles in the following residue types are not validated in this section: DDS, GOL, MG, 2DA, NA

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	0.31	0/4406	0.48	0/5964
2	B	0.73	0/249	1.40	6/382 (1.6%)
3	C	1.25	3/271 (1.1%)	1.80	10/417 (2.4%)
All	All	0.45	3/4926 (0.1%)	0.72	16/6763 (0.2%)

All (3) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	C	205	DT	C5-C6	11.66	1.42	1.34
3	C	205	DT	N1-C2	6.43	1.43	1.38
3	C	205	DT	O4'-C1'	5.69	1.49	1.42

The worst 5 of 16 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
3	C	205	DT	C2-N3-C4	-10.54	120.87	127.20
3	C	205	DT	N3-C4-C5	8.62	120.37	115.20
2	B	106	DC	O4'-C1'-N1	-8.02	102.39	108.00
3	C	205	DT	C5-C6-N1	-8.02	118.89	123.70
3	C	205	DT	N1-C1'-C2'	7.63	127.09	112.60

There are no chirality outliers.

There are no planarity outliers.

### 5.2 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 hydrogens added by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit,



and the number in parentheses is this value normalized per 1000 atoms of the molecule in the chain. The Symm-Clashes column gives symmetry related clashes, in the same way as for the Clashes column.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	4313	0	0	6	0
2	B	242	0	0	0	0
3	C	243	0	0	0	0
4	A	1	0	0	0	0
4	B	2	0	0	0	0
5	A	1	0	0	0	0
6	A	6	0	8	1	0
7	A	29	0	12	1	0
8	A	438	0	0	2	0
8	B	44	0	0	0	0
8	C	66	0	0	0	0
All	All	5385	0	20	7	0

Clashscore is defined as the number of clashes calculated for the entry per 1000 atoms (including hydrogens) of the entry. The overall clashscore for this entry is 2.

The worst 5 of 7 close contacts within the same asymmetric unit are listed below.

Atom-1	Atom-2	Distance(Å)	Clash(Å)
7:A:835:DDS:H8	7:A:835:DDS:O5'	2.07	0.54
1:A:786:GLU:CG	8:A:1014:HOH:O	2.57	0.52
1:A:469:ARG:NH2	8:A:860:HOH:O	2.50	0.45
1:A:644:SER:O	1:A:649:VAL:CG1	2.66	0.44
1:A:557:THR:OG1	1:A:561:HIS:CE1	2.71	0.43

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	540/540 (100%)	523 (97%)	13 (2%)	4 (1%)	30 13

All (4) Ramachandran outliers are listed below:

Mol	Chain	Res	Type
1	A	649	VAL
1	A	831	LYS
1	A	586	VAL
1	A	503	ILE

### 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	444/441 (101%)	436 (98%)	8 (2%)	71	58

5 of 8 residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	649	VAL
1	A	794	GLU
1	A	682	LEU
1	A	538	LEU
1	A	673	MET

Some sidechains can be flipped to improve hydrogen bonding and reduce clashes. There are no such sidechains identified.

### 5.3.3 RNA ⓘ

There are no RNA chains in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

1 non-standard protein/DNA/RNA residue is 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	2DA	B	112	3,2,4	20,22,23	2.77	7 (35%)	28,31,34	3.33	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	2DA	B	112	3,2,4	-	0/6/18/19	0/1/3/3

The worst 5 of 7 bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	B	112	2DA	P-OP1	8.90	1.56	1.46
2	B	112	2DA	C8-N9	4.72	1.43	1.36
2	B	112	2DA	C4-N3	3.73	1.41	1.35
2	B	112	2DA	C2-N1	3.46	1.40	1.33
2	B	112	2DA	O4'-C1'	2.34	1.48	1.42

The worst 5 of 7 bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	B	112	2DA	N3-C2-N1	-11.15	119.39	128.71
2	B	112	2DA	C4'-O4'-C1'	-8.89	106.34	110.05
2	B	112	2DA	C2'-C1'-N9	6.56	125.77	112.66
2	B	112	2DA	C8-N9-C4	3.81	109.81	106.90
2	B	112	2DA	N3-C4-N9	2.98	130.82	125.43

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 5.5 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 5.6 Ligand geometry

Of 6 ligands modelled in this entry, 4 are monoatomic - leaving 2 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$
6	GOL	A	834	-	5,5,5	0.33	0	5,5,5	0.33	0
7	DDS	A	835	4	31,31,31	1.26	5 (16%)	48,48,48	2.11	11 (22%)

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
6	GOL	A	834	-	-	0/4/4/4	0/0/0/0
7	DDS	A	835	4	-	0/20/31/31	0/1/3/3

All (5) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
7	A	835	DDS	C6-N6	3.35	1.45	1.35
7	A	835	DDS	C5'-C4'	-2.90	1.42	1.50
7	A	835	DDS	C3'-C2'	-2.37	1.47	1.54
7	A	835	DDS	C4-N9	-2.26	1.34	1.37
7	A	835	DDS	PG-O3B	-2.08	1.56	1.60

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

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
7	A	835	DDS	N3-C2-N1	-9.39	120.86	128.71
7	A	835	DDS	N3-C4-N9	4.20	133.01	125.43
7	A	835	DDS	PB-O3B-PG	-3.71	120.80	131.68
7	A	835	DDS	C4'-O4'-C1'	-3.27	108.68	110.05
7	A	835	DDS	C8-N9-C4	3.03	109.21	106.90

There are no chirality outliers.

There are no torsion outliers.

There are no ring outliers.

## 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 ⓘ

### 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, 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	538/540 (99%)	-0.45	5 (0%) 81 78	20, 35, 75, 137	0
2	B	12/12 (100%)	-0.83	0 100 100	24, 26, 50, 51	0
3	C	12/12 (100%)	-0.92	0 100 100	22, 27, 46, 47	0
All	All	562/564 (99%)	-0.47	5 (0%) 81 78	20, 35, 73, 137	0

All (5) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	648	GLY	5.4
1	A	649	VAL	4.6
1	A	503	ILE	4.1
1	A	653	ALA	2.4
1	A	645	TRP	2.3

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

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	RSR	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
2	2DA	B	112	20/21	0.09	1.29	21,25,28,29	0

### 6.3 Carbohydrates ⓘ

There are no carbohydrates in this entry.

## 6.4 Ligands

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	RSR	LLDF	B-factors(Å <sup>2</sup> )	Q<0.9
4	MG	B	1	1/1	0.12	18.83	36,36,36,36	0
5	NA	A	833	1/1	0.12	4.21	50,50,50,50	0
7	DDS	A	835	29/29	0.11	1.93	27,45,66,271	0
4	MG	A	1	1/1	0.10	1.15	36,36,36,36	0
6	GOL	A	834	6/6	0.11	0.92	49,60,64,70	0
4	MG	B	113	1/1	0.11	0.05	34,34,34,34	0

## 6.5 Other polymers

There are no such residues in this entry.