STANDARD RUPTURE FORMAT
Version 2.0

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Introduction

The Standard Rupture Format (SRF) is an ASCII based file format that provides a complete kinematic description for earthquake ruptures.

The general fault surface is represented by a distribution of point sources (subfaults). Each point source description contains all the necessary kinematic information to compute the contribution of that subfault to the total response of the fault rupture. In principle, there is no inherent restriction on the geometry of the fault surface or on the spacing and distribution of the point sources used to describe the fault surface. However, it is recognized that most current methods used to develop or model fault ruptures are based on descriptions that employ planar rectangular segments. To facilitate the exchange (and retention) of fault representations in this format, the description presented below allows for the (optional) inclusion of information that specifies the planar segments used to define the fault surface.

Aki & Richards convention for strike, dip and rake are used for all the source descriptions. Slip is specified in three orthogonal directions, two within the subfault surface, and the third in the direction of the outward normal to that surface. This allows for the possibility of time dependent rake and/or fault opening. Figure 1 illustrates the coordinate system conventions used in this description.

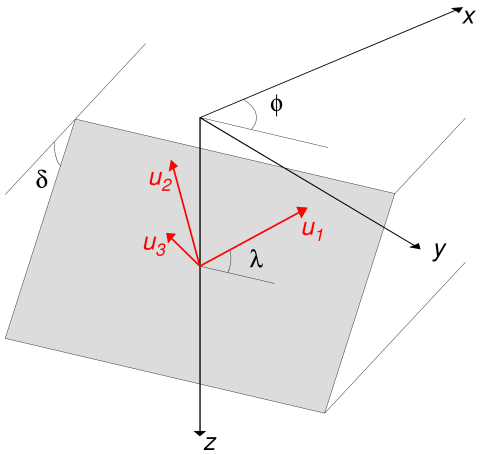

Figure 1: Coordinate system conventions for an individual subfault. The system (x, y, z) is the global system (e.g., x = north, y = east, z = down). The system (u_1, u_2, u_3) is the local system in which the slip is specified. The axes u_1 and u_2 are tangent to the rupture surface and u_3 is the outward normal to the surface. The strike (ϕ), and dip (δ) are the same as Aki & Richards. Strictly speaking, the rake (λ) defines the orientation of the u_1 axis (with u_2 at $\lambda+90^o$).

For a pure shear dislocation with constant rake, all slip will be in the u_1 direction. Incorporating time variable rake is handled using two orthogonal components (u_1 and u_2) each with a unique slip-rate function. In this case λ can be specified such that u_1 and u_2 bracket the average rake direction.

Version 2.0 Format Specification

The file type as described below is in ASCII format to allow for easy exchange and editing capabilities. The general file format is as follows:

VERSION
HEADER BLOCK (optional)
DATA BLOCK

where

VERSION	version identifier (e.g., 2.0)
HEADER BLOCK	comments and general fault description
DATA BLOCK	detailed information for all point sources covering fault surface

HEADER BLOCK

The optional **HEADER BLOCK** consists of a series of lines describing the general features of the rupture and fault surfaces. Comment lines are permitted in the **HEADER BLOCK** and are denoted by the '#' character appearing at the beginning of the line.

Following the comment lines, an optional description for one or more planar segments representing the fault can appear. Additional descriptive formats can be developed and added as needed.

For the planar segment format, the first line is:

PLANE NSEG

where

PLANE	flag specifying that following lines describe planar fault
NSEG	total number of segments in fault description

Then for each fault segment, the following two lines are needed:

ELON ELAT NSTK NDIP LEN WID
STK DIP DTOP SHYP DHYP

where (for this segment)

ELON	top center longitude
ELAT	top center latitude
NSTK	number of point sources (subfaults) along strike
NDIP	number of point sources (subfaults) down-dip
LEN	segment length (km)

WID segment width (km)
STK segment strike
DIP segment dip
DTOP depth to top of fault segment (km)
SHYP along strike location (from top center) of hypocenter for this segment (km)
DHYP down-dip location (from top edge) of hypocenter for this segment (km)

The above description is repeated for each additional segment, up to the total of NSEG.

Here is an example description for a 3 segment fault:

```
PLANE 3
 -119.0985   35.0140     2     2    16.00    12.00
   95   40     3.00    -2.00    10.00
 -118.9582   35.1398     3     2    30.00    18.00
   49   80     0.00   -15.00    10.00
 -118.6702   35.2318     4     2    20.00    15.00
  210   75     0.00    10.00    12.00
```

DATA BLOCK

Following the optional header lines described above are the required **DATA BLOCK** lines. The **DATA BLOCK** consists of one or more **POINT BLOCK** structures. Strictly speaking, only one **POINT BLOCK** structure is required, and it can contain the information for all of the point sources covering the fault. However, the use of multiple **POINT BLOCK** structures is convenient for describing the individual segments of a multi-segment fault rupture (i.e., one **POINT BLOCK** structure for each segment).

The first line in each **POINT BLOCK** is:

POINTS NP

where

POINTS flag specifying that following lines describe point sources (subfaults)
NP number of point sources (subfaults) to follow

Following this are blocks of lines containing information about each of the NP point sources (subfaults). The format of the lines in each of these NP blocks is:

LON LAT DEP STK DIP AREA TINIT DT VS DEN
RAKE SLIP1 NT1 SLIP2 NT2 SLIP3 NT3
SR1[1] SR1[2] SR1[3] . . . SR1[NT1]
SR2[1] SR2[2] SR2[3] . . . SR2[NT3]
SR3[1] SR3[2] SR3[3] . . . SR3[NT3]

where

LON	longitude of subfault center
LAT	latitude of subfault center
DEP	depth of subfault center (km)
STK	strike
DIP	dip
AREA	area of subfault (cm^2)
TINIT	initiation time when rupture reaches subfault center (sec)
DT	time step in slip velocity function (sec)
VS	shear wave velocity at source point (cm/sec), enter -1 if not known
DEN	density at source point (g/cm^3), enter -1 if not known
RAKE	direction of u_1 axis (rake direction)
SLIP1	total slip in u_1 direction (cm)
NT1	number of time points in slip rate function for u_1 direction
SLIP2	total slip in u_2 direction (cm)
NT2	number of time points in slip rate function for u_2 direction
SLIP3	total slip in u_3 (surface normal) direction (cm)
NT3	number of time points in slip rate function for u_3 direction
SR1[1],…,SR1[NT1]	slip rate at each time step for u_1 direction (cm/sec)
SR2[1],…,SR2[NT2]	slip rate at each time step for u_2 direction (cm/sec)
SR3[1],…,SR3[NT3]	slip rate at each time step for u_3 direction (cm/sec)

Although the general format given here allows for slip in all three directions (u_1, u_2, u_3), most cases will have only one (u_1) or two (u_1, u_2) non-zero slip components. In these situations, the remaining slip components, as well as the number of time points for the slip rate function, are specified as "0".

Changes from Version 1.0

1. Added option to specify comment lines within the **HEADER BLOCK**. Comment lines are denoted with a leading '#'.

2. Added fields for VS (shear wave velocity in cm/sec) and DEN (density in g/cm^3) to the subfault description. Values for these parameters may not always be available (e.g., for scenario ruptures generated for an unspecified region), in which case a value of -1 should be entered.

3. Added option to subdivide the specification of the individual point source descriptions into multiple POINT BLOCK structures (version 1.0 requires that the subfault descriptions for all fault segments be included in a single POINT BLOCK structure).

Examples

Example 1: Single Point Source

```
2.0
#
# Example 1: This is an example of the simplest form of a SRF file.
#
# This file represents a point source with strike=291, dip=59 and rake=142.
# Since the source is represented kinematically, it has a slip (16.32 cm)
# over an area (2.64926e+11 cm*cm) with rigidity given by Vs*Vs*den
# [(3.64e+05 cm/s)*(3.64e+05 cm/s)*(2.67 g/cm^3)=3.54e+11 dyne/cm^2].
# This gives a seismic moment of 1.53e+24 dyne-cm (Mw 5.42).
#
# The slip-rate function is a simple isosceles triangle discretized at 0.025 sec.
# Note that the slip-rate function is zero for all time points after those
# listed in the file (i.e., the last time point is implicitly zero and
# is not included).
#
# Other useful information that might be included in these comment lines is documentation
# of the source of the rupture e.g.,
#
#      "Example 1 is a sample SRF generated by hand on Fri Nov 21 12:52:16 PST 2014
#       (Robert Graves, <rwgraves@usgs.gov>)."
#
# or the usable bandwidth of the rupture, e.g.,
#
#      "This model is applicable in the bandwidth T>10 sec."
#
POINTS 1
 -117.7610  33.9530  14.70  291  59  2.64926e+11  0.0000  2.50000e-02  3.64000e+05  2.67000e+00
 142    16.32      4     0.00      0     0.00      0
  0.00000e+00  1.63200e+02  3.26400e+02  1.63200e+02
```

Example 2: Single Planar Fault

```
2.0
#
# Example 2a: Single planar fault.
#
# Following these comment lines, a description of the fault plane location and
# geometry is given by 3 lines starting with "PLANE 1".  Note that this description
# of the fault plane is optional. However, this information is useful in that it
# provides a concise description of the fault (e.g. for plotting purposes, etc.).
#
# The kinematic rupture information begins with the line "POINTS 4", which means this
# rupture is represented by 4 subfaults. The detailed description of the rupture on
# each subfault follows this line. Note that each subfault has a single slip-rate
# function with the direction of slip (rake) varying from subfault to subfault.
#
# Other useful information that might be included in these comment lines is documentation
# of the source of the rupture e.g.,
#
#      "Example 2a is a sample rupture scenario generated Mon Nov 24 11:50:22 PST 2014
#       with the code "genslip-v3.3.2" (Robert Graves, <rwgraves@usgs.gov>)."
#
# or the usable bandwidth of the rupture, e.g.,
#
#      "This rupture is applicable in the bandwidth T>3 sec."
#
PLANE 1
 -119.0985   35.0140     2     2    16.00    12.00
  95   40     3.00    -2.00    10.00
POINTS 4
 -119.1459  34.9826  4.9284  95  40  4.80000e+11  2.6465  1.00000e-01  3.20000e+05  2.65000e+00
  82     8.59      6     0.00      0     0.00      0
  0.00000e+00  5.91682e+01  1.16849e+01  8.57081e+00  4.81257e+00  1.63265e+00
 -119.0585  34.9763  4.9284  95  40  4.80000e+11  2.4801  1.00000e-01  3.20000e+05  2.65000e+00
 120    43.18      7     0.00      0     0.00      0
  0.00000e+00  2.88510e+02  5.43680e+01  4.31742e+01  2.83736e+01  1.38752e+01
  3.50832e+00
 -119.1503  34.9414  8.7851  95  40  4.80000e+11  0.0000  1.00000e-01  3.60000e+05  2.75000e+00
  76    26.61      2     0.00      0     0.00      0
  0.00000e+00  2.66114e+02
 -119.0629  34.9352  8.7851  95  40  4.80000e+11  0.1637  1.00000e-01  3.60000e+05  2.75000e+00
  82   118.54      9     0.00      0     0.00      0
  0.00000e+00  6.18123e+02  2.28298e+02  1.12802e+02  9.21321e+01  6.71185e+01
  4.17206e+01  1.99587e+01  5.27757e+00
```

Example 3: Multi-segment Rupture

```
2.0
#
# Example 3a: Multi-segment fault rupture (3 segments).
#
# This rupture consists of 3 planar rectangular segments. Following these comment lines,
# a description of the location and geometry of the individual fault segments is given by
# 7 lines starting with "PLANE 3"; 2 lines for each of the 3 fault segments. Note that
# this description of the fault segments is optional. However, this information is useful in
# that it provides a concise description of the fault (e.g. for plotting purposes, etc.).
#
# The kinematic rupture information for each segment begins with a line "POINTS <NP>".
# There are 3 of these in this file, one for each segment, and the detailed subfault
# information for each segment follows the "POINTS <NP>" line. The number of subfaults
# (<NP>) can be different for each segment (<NP>= 4, 6, 8, respectively for the
# 3 segments in this file).
#
# Other useful information that might be included in these comment lines is documentation
# of the source of the rupture e.g.,
#
#      "Example 3a is a sample rupture scenario generated Mon Nov 24 12:19:29 PST 2014
#       with the code "genslip-v3.3.2" (Robert Graves, <rwgraves@usgs.gov>)."
#
# or the usable bandwidth of the rupture, e.g.,
#
#      "This rupture is applicable in the bandwidth T>8 sec."
#
PLANE 3
 -119.0985   35.0140     2     2    16.00    12.00
  95   40     3.00    -2.00    10.00
 -118.9582   35.1398     3     2    30.00    18.00
  49   80     0.00   -15.00    10.00
 -118.6702   35.2318     4     2    20.00    15.00
 210   75     0.00    10.00    12.00
POINTS 4
 -119.1459  34.9826  4.9284  95  40  4.8000e+11  3.9808  5.00000e-01  -1.00000e+00  -1.00000e+00
  90    78.56      3     0.00      0     0.00      0
  0.00000e+00  1.15372e+02  4.17567e+01
 -119.0585  34.9763  4.9284  95  40  4.8000e+11  3.9946  5.00000e-01  -1.00000e+00  -1.00000e+00
  94   124.76      3     0.00      0     0.00      0
  0.00000e+00  1.86001e+02  6.35258e+01
 -119.1503  34.9414  8.7851  95  40  4.8000e+11  0.0000  5.00000e-01  -1.00000e+00  -1.00000e+00
  20   248.43      2     0.00      0     0.00      0
  0.00000e+00  4.96865e+02
 -119.0629  34.9352  8.7851  95  40  4.8000e+11  4.6669  5.00000e-01  -1.00000e+00  -1.00000e+00
 115     0.00      0     0.00      0     0.00      0
POINTS 6
 -118.9772  35.0207  4.4316  49  80  9.0000e+11  8.5605  5.00000e-01  -1.00000e+00  -1.00000e+00
   5    81.21      3     0.00      0     0.00      0
  0.00000e+00  1.06553e+02  5.58618e+01
 -118.8944  35.0797  4.4316  49  80  9.0000e+11 11.7304  5.00000e-01  -1.00000e+00  -1.00000e+00
 -11   102.76      3     0.00      0     0.00      0
  0.00000e+00  1.44288e+02  6.12220e+01
 -118.8115  35.1386  4.4316  49  80  9.0000e+11 16.1476  5.00000e-01  -1.00000e+00  -1.00000e+00
   7    61.28      2     0.00      0     0.00      0
  0.00000e+00  1.22558e+02
 -118.9659  35.0102 13.2949  49  80  9.0000e+11  6.0000  5.00000e-01  -1.00000e+00  -1.00000e+00
 -48   302.30      4     0.00      0     0.00      0
  0.00000e+00  3.70640e+02  2.02352e+02  3.16073e+01
 -118.8831  35.0691 13.2949  49  80  9.0000e+11 12.2177  5.00000e-01  -1.00000e+00  -1.00000e+00
 -14     0.00      0     0.00      0     0.00      0
 -118.8002  35.1280 13.2949  49  80  9.0000e+11 14.2068  5.00000e-01  -1.00000e+00  -1.00000e+00
  60   130.10      2     0.00      0     0.00      0
  0.00000e+00  2.60198e+02
POINTS 8
 -118.6980  35.3227  3.6222 210  75  3.7500e+11 24.2740  5.00000e-01  -1.00000e+00  -1.00000e+00
  52    62.62      3     0.00      0     0.00      0
  0.00000e+00  8.55161e+01  3.97197e+01
```

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```
-118.7255  35.2838  3.6222 210  75  3.7500e+11 20.3903  5.00000e-01  -1.00000e+00  -1.00000e+00
 73   259.66      6     0.00      0     0.00      0
 0.00000e+00  3.57517e+02  7.02898e+01  5.18295e+01  2.94211e+01  1.02659e+01
-118.7530  35.2449  3.6222 210  75  3.7500e+11 20.5304  5.00000e-01  -1.00000e+00  -1.00000e+00
 58    89.32      3     0.00      0     0.00      0
 0.00000e+00  1.20825e+02  5.78088e+01
-118.7805  35.2060  3.6222 210  75  3.7500e+11 18.2282  5.00000e-01  -1.00000e+00  -1.00000e+00
 22   173.57      4     0.00      0     0.00      0
 0.00000e+00  2.04059e+02  1.03183e+02  3.98911e+01
-118.7165  35.3314 10.8667 210  75  3.7500e+11 21.5693  5.00000e-01  -1.00000e+00  -1.00000e+00
 90   138.38      2     0.00      0     0.00      0
 0.00000e+00  2.76766e+02
-118.7440  35.2925 10.8667 210  75  3.7500e+11 20.7451  5.00000e-01  -1.00000e+00  -1.00000e+00
 45    77.84      2     0.00      0     0.00      0
 0.00000e+00  1.55686e+02
-118.7715  35.2536 10.8667 210  75  3.7500e+11 18.3628  5.00000e-01  -1.00000e+00  -1.00000e+00
-15   102.13      3     0.00      0     0.00      0
 0.00000e+00  1.33963e+02  7.02981e+01
-118.7990  35.2147 10.8667 210  75  3.7500e+11 18.0000  5.00000e-01  -1.00000e+00  -1.00000e+00
 35     0.00      0     0.00      0     0.00      0
```