**README file for ASSEMBLED Data Set 05-022 "SAFOD-PGD"**

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An 80-level, clamped 3-component, high-frequency bore hole seismic array was installed and operated in the SAFOD main hole by Paulsson Geophysical Services, Incoroprated (P/GSI) and recorded on Geode seismic data loggers by Geometrics, Incorporated in late April and early May, 2005.  This assembled data set contains all data recorded during this experiment.  The data holdings begin on April 29, 2005 at 04:29 UTC and continue, with intermittent breaks, until May 11, 2005 at 15:00 UTC.

There are three basic data sets contained in these recordings.

1. "Zero offset" check shots.  Small(5-10 lb) explosions were fired on the SAFOD site into the P/GSI array during deployment when the array was locked at each of the three positions.  Information on the shots are contained in the file "small_offset_shot_locs.doc" and a map of the layout is in "Small Offset Shot Map.pdf".

2. "Virtual earthquakes" created by 80 lb explosions detonated very close to seismic stations in the PASO array of Steve Roecker and Cliff Thurber.  The shot locations and origin times are in the file "Pasotres_shottimes.doc".

3. "Continuous recording".  During the recording period, digital helicorders and bi-hourly spectrograms of the Northern Califorina Seismic Network were scanned to prepare a preliminary catalog of local earthquakes.  This unedited list is contained in the file "PrelimCatalog.txt".

The P/GSI array is deployed on tubing, with each 3-component geophone assembly housed in a specialized assembly (pod) that is integrated into the tubing string.  Each pod is pressed against the inside of the well casing by an inflatable bladder that is pressurized from the surface.

The array was clamped at three positions in the well.  First when the highest pod just entered the well.  Second, at an intermediate postion, with some overlap of the high postion, and finally at the depth where the main recording occurred.  The geophones were Geophone locations were determined using the geophone spacing (50 ft), the precisely known lengths of deployment tubing used by P/GSI, and the geometry of the well determined by gyro surveys.  Their locations are given in the files named:

PGSIarray_rec_coords_pos1.txt          Shallow
PGSIarray_rec_coords_pos2.txt          Middle
PGSIarray_rec_coords_pos3.txt          Deep

Each file contains 1 row per pod, from shallowest to deepest.  Columns are:
REC_SLOT   pod number
WELL_DEP   measured depth in meters along the well trajectory relative to K.B. (31 ft above ground level)
REC_DEP    vertical distance below K.B. to pod in meters
REC_X             Easting of pod in UTM NAD27 coordinates (meters)
REC_Y             Northing of pod in UTM NAD27 coordinates (meters)
REC_ELEV   Elevation relative to sea level in UTM NAD27 coordinates (meters)

For reference, the coordinates of the SAFOD main hole well head are 35.9742039 N, -120.5521414 E, and 660.5 m above m.s.l. in the WGS 84 reference frame, corresponding to 720807.06 m Easting and 3983663.97 m Northing in UTM NAD27.

The geophones in the P/GSI array are omni-directional OYO Geo Space SMC-1850 geophones. These geophones have a natural frequency of 15 Hz and a damping of 0.47. The data sheet is in the file "2003.02.25 oyo smc-1850 omni.pdf". The nominal geophone output is 0.402 V/cm/sec.

Geophone orientations were determined for the deep position by P/GSI using the well bore geometry and hodograms from shots. Each pod contains one omni-directional geophone oriented along the axis of the well and two in the transverse plane. The orientation of the Axial component is known from the well geometry alone. The determined orientations are given in the file "PGSIarray_3C_dip_azmiuth.txt". Columns (as described by Alex Goertz of P/GSI) are:

REC_SLOC = receiver number (1 being the shallowest)
GEO_COMP = geophone component, with

        Axial      1
        R1         3
        R2         2
        R1 is defined to be 90 degrees to the right of R2, (i.e., on your right hand, the thumb points to Axial, the index finger points to R1 and the midlle finger points to R2)
ORIG_DIP = dip of the component, -90 degress points vertically up, +90 points vertically down
ORIG_AZM = azimuth w/ respect to North

The orientation vector defined by the angles points in the direction of positive impulse response of the geophone. Note that REC_SLOT 1 in this file corresponds to REC_SLOT 161 in the coordinate file

The orentation of the Phase 1 portion of the SAFOD main hole, drilled in 2004, are in the file "SAFOD definitive survey.txt".

Geode seismic data loggers provided by Geometrics, Inc. were used to record the data in SEG-2 format with timing provided by a GPS clock. All files in this assembled data set are copies of the field recordngs and are in SEG-2 format. Data were samples at 4000 samples/second and recorded in 16 second blocks. The SEG-2 header lists the acquisition time. NOTE that this time is exactly 36 seconds old (early) relative to the correct UTC time. (The time is 52 seconds early minus the 16 second offset = 36 seconds old.) Digital values in the files can be converted to mV by multiplying by the DESCALING_FACTOR in the SEG-2 header (4.270400E-005). NOTE that there is a small amount of data overlap between files of between 31 and 33 samples. Although each file starts at exactly the time given in the header plus 36 seconds, the exact position of the overlap could vary by 1 sample due to drift between the digitizer's internal sampling clock and the GPS clock. The simple solution of concatinating the first 64,000 samples from each file will work adequately for most applications, but you should be aware of this issue.
There are 241 channels of data in each file, 3*80 levels + one timing channel. The channel recording order is from BOTTOM to TOP of the array, starting with R1, R2, Axial at REC_SLOT 240, followed by R1, R2, Axial at REC_SLOT 239, ... to R1, R2, Axial for REC_SLOT 161, and ended with the timing channel.