The Chicxulub impact crater and oblique impact

by

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Appendix A: Seismic reflection data processing

The 2005 seismic data was recorded in SEGY format and processing using Paradigm Focus 5.3 according to the processing flow outlined below. The first section of this appendix lists the commands used in each step of processing and the second section gives all the parameters for each command.

Section I: Processing commands

SEGY-focus format (sample file name: DSKRD_TO_DSOUT_6B)

- DSKRD
- DSKIO
- DSOUT

Geometries (sample file name: MARINE)

- DUMIN
- LINE
- PATTERN
- SOURCE

Deconvolution/spectal whitening/ sort (sample file name: CHIX6BFKDECONSORT_SPEQ.DAT)

- DSIN
- HDRMATH
- PROFILE
- FILTER
- GAIN
- EDIT
- EDIT
- EDIT
- FKBUILD
- FKAPPLY
- MCDECON
- SPEQ
- DESCALE
- SORT
- BALANCE
- DSOUT

Velocities/Mutes (sample file name: VELPICK6BSPEQ.DAT)

- DSIN

- BALANCE
- HDRMATH
- AGC
- VELDEF

Stack (sample file name: STACK6BSPEQ)

- DSIN
- NMO
- MUTE
- STACK
- DSOUT

Migrate (sample file name: MIG6BSPEQ)

- DSIN
- MIGTX
- DSOUT

Focus data format-SEGY (sample file name: GOUT6B_SPEQ)

- DSIN
- AGC
- GOUT

SEGY-focus format (sample file name: DSKRD_TO_DSOUT_6B)

- DSKRD
- DSKIO
- DSOUT

Section II: Processing parameters

SEGY- FOCUS DATA FORMAT (sample file name: DSKRD_TO_DSOUT_6B)

DSKRD

FILE- Disk file name

DSKIO

NAMOFIL- Read Multiple Data Files
PKEYNAM- Primary key header name
FILENAM- Data File name
/ew04_3/chix/focus/chix6b.1.dsk
14336 LENGTH- Data length
Repeats
NAMOFIL- Read Multiple Data Files
PKEYNAM- Primary key header name
FILENAM- Data File name
/ew04_3/chix/focus/chix6b.2.dsk
14336 LENGTH- Data length
Repeats
… repeats to /ew04_3/chix/focus/chix6b.13.dsk

DSOUT

NEW MODE- Create or modify a file (NEW/OVERWRT/APPEND/UPDATE)
AUTO TRORG- Data set format (AUTO/TRACE/VOLUME)
FLT32 ENCODE- Data sample encoding type (FLT32/INT16/INT16100/FLT1)

LABEL-User-defined Label
LABEL- Label
CHIX6b_shots

Geometries (sample file name: MARINE)

```
DUMIN
        4               SR
        1000            LENGTH
        CDP             PKEYNAM
        0               TSTART
LINE

        STATIONS    LOCNTYP
                LOCN        -Line Definition by XY Location
        1               NUMBER- Sequence number of station of CDP
        LXY             METHOD- XY coordinate of XY increment definition?
        0               X- X location
        0               Y- Y location
                        ELEVN- Surface elevation of station
        10              IXL- First crossline label (3D)
        10              ISL- First subline label (3D)
                REPEAT –Repeat Parameters
        21000           COUNT- Number of stations to establish in addition to
first
        12.5            XINC- Increment between stations in X direction
        0               YINC- Increment in stations in Y directions
                CDP- CDL Line and Model Definition
        245             START- Station number of first CDP
                        END- Station number of last CDP
        0               INC1-  Number of CDPs between adjacent stations
        1               INC2- Number of CDPs between adjacent locations along a 3D crossline
        1               FIRST- Sequence number of first CDP
                        SHIFT- Percentage of CDP interval by which to shift CDP locations


PATTERN
        480             PATNAME- Pattern name
        YES             OVERWRT- Overwrite pattern if it previously exists in database (YES/NO)?
        SHORT           PATSW- Print summary (SHORT) or complete (LONG) channel location
                        description
        GEOMETRY    LINE- Line name

                SPREAD- Pattern Specification by X and Y Increment
        480             NCHAN- Number of channels in spread
        480             START- Channel number nearest shot
        -112.5          XOFF- X offset from shot to nearest receiver channel
```

-12.5 DX- X increment between channels
0 YOFF- Y offset from shot to nearest receiver channel
0 DY- Increment or decrement of the Y offset between channels

SOURCE
IMPER OFFTYPE- Offset specification of shot to nearest channel
PATLINE- Line name for pattern retrieval
SHOT- Shot Location Definition
1 NUMBER- Shot sequence number
489 STATION- Station number nearest to shot location
0.5 OFFSET1- Inline offset of shot to nearest station
0 OFFSET2- Perpendicular offset of shot to nearest station
480 PATNAME- Pattern name
480 PATLOC- Station number of pattern origin

THRU- Shot Repetition Parameters (Thru Last Qualified Shot)
5000 TNUM- Last qualified shot number
4 STATINC- Station increment for repeated shots
0.5 OFFSET1- Inline offset for repeated shots
0 OFFSET2- Perpendicular offset for repeated shots
4 PATINC- Cable moveup increment (in stations)

Deconvolution/ spectral whitening/ sort (sample file name: CHIX6BFKDECONSORT_SPEQ.DAT)

DSIN

14336 LENGTH- Data length (ms)
STARTTM- Start time (ms)
ENDTM- End time (ms)

LABEL- Catalog User Label
LABEL- Catalog name
CHIX6b_shots
FILEID- File name
FILEID- Catalog file ID
0000400500a00bc1.000000.00000001
ORDER- Trace Order Parameters
SHOT ORDER- Primary order
SEQNO SCNDORD- Secondary order

PKEYLST- Input Data Range by Pkey

START END
[0] 964 1567

HDRMATH

NOAUX AUX- Process auxiliary and/or data traces (NOAUX/AUX)
DEFINE- Specify Format/Length of Header Entry
WBXTIME NAME- Header entry name
FLOAT FORMAT- Format of header entry (FLOAT/INTEGER)
4 LENGTH- Length (words) of header entry

HCSUB- Subtract a Constant from a Trace Header (H1-C)
WDEPTHSO NAME1- Header (H1)
13 CONST- Constant (C)
WBXTIME OUTPUT- Name of output header entry

HCPOW- Power Trace Header by a Constant (H1 ** C)
WDEPTHSO NAME1- Header (H1)
2 CONST- Constant (C)
WBXTIME OUTPUT- Name of output header entry

HCADD- Add Trace Header to a Constant (H1 + C)

WDEPTHSO	NAME1- Header (H1)
8100	CONST- Constant (C)
WBXTIME	OUTPUT- Name of output header entry

DEFINE- Specify Format/Length of Header Entry

WBTIME	NAME- Header entry name
FLOAT	FORMAT- Format of header entry (FLOAT/INTEGER)
4	LENGTH- Length (words) of header entry

HSQRT- Compute Square Root of Header Entry

WBXTIME	NAME1- Header (H1)
WBTIME	OUTPUT- Name of output header entry

HCMUL- Multiply Trace Header by a Constant (H1 x C)

WBTIME	NAME1- Header (H1)
2	CONST- Constant (C)
WBTIME	OUTPUT- Name of output header entry

WBTIME	NAME1- Header (H1)
1520	CONST- Constant (C)
WBTIME	OUTPUT- Name of output header entry

PROFILE

CHIX6B	LINAME- Line name
480	NEAREST- Number of channel nearest the shot
99999	RADN- Inline radial distance for CDP assignment
	RADP- Perpendicular radial distance for CDP assignment
SHOT	PKEYNAM- Assign trace header values based on shots or ffid (SHOT/FFID)?
112	PATLINE- Specify line name for cable pattern retrieval

FILTER

Shot	PKEYNAM- Header name for filter applications
NO	PFIL- Print filter coefficients?
NO	PLOT- Plot filter coefficients?
TIME	DOMAIN- Domain of filter application
ZERO	PHASE- Zero or minimum phase filter

BAND- Trapezoidal Filter
BP TYPE- Type of band filter
HANN TAPER- Filter tape type
151 NFPTS- Filter length (# points)

	TS	TE	F1	F2	F3	F4
[0]	0	14336	3	8	75	100

GAIN
Shot PKEYNAM- Header name for spatially variant gain
EXP INTERP- Linear or exponential interpolation?

SPHDIV- Spherical Divergence Correction
1 FACTOR- General scalar
0 VOPTION- Power value of the average velocity at time T
1 TOPTION- Power value of time T
VELDEFN IDENT- Database velocity function file name
LINE- Line name
NONE OFFDEP- Offset dependant spherical divergence correction
repeats

EDIT
Shot PKEYNAM- Header name for ensemble editing
Chan SKEYNAM- Header name for individual trace editing
SEL- Edit Traces Within Ensembles
964 PKEYFR- First ensemble within range
1567 PKEYTO- Last ensemble within range
KILL OPER- Zero or omit traces
NORANCE RANGE- Edit range of traces or trace list
Repeats[0]
14 SKEY- Trace header value
Repeats[1]
312 SKEY- Trace header value
Repeats[2]
383 SKEY-Trace header value

EDIT
Shot PKEYNAM- Header name for ensemble editing
Chan SKEYNAM- Header name for individual trace editing
SEL- Edit Traces Within Ensembles

989 PKEYFR- First ensemble within range
991 PKEYTO- Last ensemble within range
KILL OPER- Zero or omit traces
RANGE RANGE- Edit range of traces or trace list
Repeats[0]
145 SKEY- Trace header value
Repeats[1]
155 SKEY- Trace header value

EDIT
Shot PKEYNAM- Header name for ensemble editing
Chan SKEYNAM- Header name for individual trace editing
ALL- Edit Entire Ensembles
KILL OPER- Zero or omit trace ensembles
NORANCE RANGE- Edit range of ensembles or list of ensembles
KILL OPER- Zero or omit traces
Repeats[0]
1567 SKEY- Trace header value

FKBUILD
FIDENT- Database filter file name
fkbuild
Dip- Dip Filter (ms/trace) Specification

	DIPL	DIPH
[0]	-25	-7

TAPER- Taper Parameters
COSINE TYPE- Filter taper type
7 NMPTS- Taper length (# points)
Repeats
DESIGN- Filter Design Parameters
50 NTPAD- Number of traces to pad input data
REJECT MODE- Design pass or reject filter
0 PERCENT- Percentage of unfiltered data to retain in reject zone
TLEN- Trace length (ms) over which to design filter
50 NSPAD- Number of samples to add to input trace length

SAVE- Save Filter to Database
DUMMY- Not implemented
IDENT- Database filter file storage name

Fkbuild

LINE- Line name

FKAPPLY

FIDENT- Database filter file name

Fkbuild

LINE- Line name

MCDECON

SHOT	PKEYNAM- Primary interpolation header name
OFFSET	SKEYNAM- Secondary interpolation header name
PE	SCALING- Trace amplitude scaling method
	SCVAL- Scalar to use with INEQU option
NODEC	DECSW- Autocorrelation decimation
CONST	ACTION- Autocorrelation averaging method
5	NSUM- Number of channels over which to sum autocorrelations
	KEYDEF- Define Primary and Secondary Key Values
1	PKEY- Primary interpolation key value
112	SKEY1- First secondary interpolation key value (SKEY1)
6112	SKEY2- Last secondary interpolation key value (SKEY2)

GAP- Predictive (GAP) Operator

143	NFPTS- Filter length (# points)
POINTS	TYPE- Gap units
30	GAP- Gap length
0.1	PW- Percentage of white noise

	TDS1	TDE1	TDS2	TDE2	TAS1	TAE1	TAS2	TAE2
[0]	500	14336	8000	14336	0	2000	0	7000
[1]	3000	7000	7000	11000	4000	14336	9500	14336

SPEQ

250 AGCLEN- AGC gate length (ms)

FGATES- Dimensions of Frequency Pass Bands

	L050	L00N	HI0N	HI50	REPEAT
[0]	7	8	9	10	31

SPECOUT- Amplitude Spectrum of Desired Output

	FREQ	AMP
[0]	3	0
[1]	8	1
[2]	75	1
[3]	100	0

DESCALE- Store Calculated Scalars to Trace Headers

DESCALE

SPEQ	HDRNAM- Name of trace header entry containing scalars
CLEAR	CLEAR- Clear scalar values from trace header

SORT

120	MAXFOLD- Maximum fold
57601	WINDOW- Number of traces to hold for proper sorting
MEMORY	RESTYPE- Disk or memory?
PRINT	PRINT- Whether to print the sort output
	MAJOR- Primary Sort Order Parameters
Cdp	KEY- Header name for primary sorting
NORMAL	DIRECT- Do header values increase or decrease?
	FIRST- Lowest header value in sort
	LAST- Highest header value in sort
	INCR- Header increment value
	MINOR- Secondary Sort Order Parameters
Offset	KEY- Header name for secondary sorting
NORMAL	DIRECT- Do header values increase or decrease?
	FIRST- Lowest header value in sort
	LAST- Highest header value in sort
	INCR- Header increment value

BALANCE

Cdp	PKEYNAM- Primary interpolation header name
Chan	SKEYNAM- Secondary interpolation header name
1	XSHORT- Beginning secondary key value (XSHORT)
	XLONG- Last secondary key value (XLONG)
	SFACTOR- Scale factor
	GATES- Gate Design Parameters
1	PKEY- Primary key value

1 NGATES- Number of balance gates
0 TSTART- Start time of first balance gate (ms)
14336 GLENGTH- Gate length of balance gates (ms)
0 MOVEUP- Gate moveup (time) for each balance gate (ms)
repeats

DSOUT
NEW MODE- Create or modify a file (NEW/OVERWRT/APPEND/UPDATE/ACCUM)
AUTO TRORG- Data set format (AUTO/TRACE/VOLUME/BRICK)
FLT32 ENCODE- Data sample encoding type (FLT32/INT16/INT16100/FLT16/INT8)
STARTTM- Start time (ms)
ENDTM- End time (ms)

LABEL- User-defined Label
LABEL- Label
CHIX6B.fkdeconsort_speq75

Velocity/Mutes (VELPICK5SPEQ.DAT)

DSIN

14336 LENGTH- Data length (ms)
STARTTM- Start time (ms)
ENDTM- End time (ms)

LABEL- Catalog User Label
LABEL- Catalog name
CHIX5.fkdeconsort_speq75

FILEID- File name
FILEID- Catalog file ID
0000400500a00bc1.000000.00000001
RANGE- Process Data Range or Group
875 FIRST- First record
5225 LAST- Last record
50 NUM- Number of records in each group
100 INC- Record increment

BALANCE

Cdp PKEYNAM- Primary interpolation header name
SEQNO SKEYNAM- Secondary interpolation header name
1 XSHORT- Beginning secondary key value (XSHORT)
XLONG- Last secondary key value (XLONG)
SFACTOR- Scale factor

GATES- Gate Design Parameters
875 PKEY- Primary key value
1 NGATES- Number of balance gates
0 TSTART- Start time of first balance gate (ms)
14336 GLENGTH- Gate length of balance gates (ms)
0 MOVEUP- Gate moveup (time) for each balance gate (ms)
repeats

HDRMATH

NOAUX AUX- Process auxiliary and/or data traces (NOAUX/AUX)
DEFINE- Specify Format/Length of Header Entry
WBXTIME NAME- Header entry name

FLOAT FORMAT- Format of header entry (FLOAT/INTEGER)
4 LENGTH- Length (words) of header entry

HCSUB- Subtract a Constant from a Trace Header (H1-C)
WDEPTHSO NAME1- Header (H1)
13 CONST- Constant (C)
WBXTIME OUTPUT- Name of output header entry

HCPOW- Power Trace Header by a Constant (H1 ** C)
WDEPTHSO NAME1- Header (H1)
2 CONST- Constant (C)
WBXTIME OUTPUT- Name of output header entry

HCADD- Add Trace Header to a Constant (H1 + C)
WDEPTHSO NAME1- Header (H1)
8100 CONST- Constant (C)
WBXTIME OUTPUT- Name of output header entry

DEFINE- Specify Format/Length of Header Entry
WBTIME NAME- Header entry name
FLOAT FORMAT- Format of header entry (FLOAT/INTEGER)
4 LENGTH- Length (words) of header entry

HSQRT- Compute Square Root of Header Entry
WBXTIME NAME1- Header (H1)
WBTIME OUTPUT- Name of output header entry

HCMUL- Multiply Trace Header by a Constant (H1 x C)
WBTIME NAME1- Header (H1)
2 CONST- Constant (C)
WBTIME OUTPUT- Name of output header entry

HCDIV- Divide Trace Header by a Constant (H1 / C)
WBTIME NAME1- Header (H1)
1520 CONST- Constant (C)
WBTIME OUTPUT- Name of output header entry

AGC
1000 AGCGATE- Length of AGC gate (ms)
1.34e8 SFACTOR- Reference scaling factor for scalar computation

VELDEF
Cdp PKEYNAM- Primary interpolation header name

0	WVEL- Water bottom velocity
INV	INVERSE- Allow velocity inversions
CHX4FIX	IDENT- Database file name
TVRMS	TYPE- Type of velocity
Chix5	LINE- Line name
	HANDVEL- Input Velocities Manually
900	PKEY- Primary interpolation key value
0	WBT- Water bottom time
1	TABLES- Print velocity tables
0	VELIN- Velocity or depth increment for consecutive table generation
0	PKEYIN- Primary key increment for velocity or depth table generation
	WBD- Water bottom depth

	TIME	VEL	
[0]	0	1521	
[1]	156	1727	
[2]	304	2145	
[3]	512	3055	
[4]	968	4067	
[5]	1600	4823	
[6]	2636	5293	
[7]	7868	6551	
[8]	10084	6796	
[9]	12116	7031	…

STACK (sample file name: STACK5SPEQ)

DSIN

14336 LENGTH- Data length (ms)
STARTTM- Start time (ms)
ENDTM- End time (ms)

LABEL- Catalog User Label
LABEL- Catalog name
CHIX5_fkdeconsort_speq75
FILEID- File name
FILEID- Catalog file ID
0000400500a00bc1.000000.00000007

PKEYLST- Input Data Range by Pkey

	START	END
[0]	422	5386

NMO

CHX4FIX	IDENT- Database velocity file name
Chix5	LINE- Line name
NMOAPP	NMOSW- NMO action
DEFAULT	HIFI- High fidelity interpolation filters for NMO

MUTE

Cdp	PKEYNAM- Primary header name for mute definition
	SKEYNAM- Secondary key name for mute definition
20	RAMPLEN- Ramp length (ms)
INT	PKEYINT- Primary key interpolation (INT/NOINT)
INT	SKEYINT- Secondary key interpolation (INT/NOINT)
MUTE	MUTESW- Apply mute function?

RESTORE- Restore Original Mute

ON	MUTETYP- Mute restoration
	ONNAME- Specify the header name for mute on restoration
	OFFNAME- Specify the header name for mute off restoration
	RAMPLEN- Mute taper (ms)

DBMUTE- Apply Database Mute Function

Chix5	LINE- Line name
CHIX5FIX	MUTEID- Name of database mute function

STACK

120 MXFOLD- Maximum fold

NOLTF- Not implemented

DSOUT

NEW MODE- Create or modify a file (NEW/OVERWRT/APPEND/UPDATE/ACCUM)

AUTO TRORG- Data set format (AUTO/TRACE/VOLUME/BRICK)

FLT32 ENCODE- Data sample encoding type (FLT32/INT16/INT16100/FLT16/INT8)

STARTTM- Start time (ms)

ENDTM- End time (ms)

LABEL- User-defined Label

LABEL- Label

CHIX5_STACK_SPEQ

MIGRATE (MIG6BSPEQ)
DSIN

LENGTH- Data length (ms)

LABEL- Catalog User Label
LABEL- Catalog name
CHIX6B_POSTFKF_SPEQ
FILEID- File name
FILEID- Catalog file ID
0000008500900bc1.000000.00000033

MIGTX
2653 NCDP- Number of CDPs to migrate
CHX6BFIX IDENT- Database velocity file name
12.5 DX- Subsurface distance between CDPs
60 DIPLIM- Maximum dip to migrate (degrees)
MUTE MUTE- Restore mute (MUTE/NOMUTE)?
INTRP INTRP- Use interpolation filters (INTRP/NOINTRP)

VSCALE- Velocity Field Smoothing and Scaling
0.9 SCALE- Velocity scaling value (decimal)
SMOOTHX- Lateral smoothing operator length (# traces)
SMOOTHT- Vertical smoothing operator length (ms)

DSOUT
NEW MODE- Create or modify a file (NEW/OVERWRT/APPEND/UPDATE/ACCUM)
AUTO TRORG- Data set format (AUTO/TRACE/VOLUME/BRICK)
FLT32 ENCODE- Data sample encoding type (FLT32/INT16/INT16100/FLT16/INT8)
LABEL- User-defined Label
LABEL- Label
CHIX6B_MIG_SPEQ_FIX90

FOCUS DATA FORMAT – SEGY (sample file name: GOUT6B_SPEQ)

DSIN

LENGTH- Data length (ms)

LABEL- Catalog User Label
LABEL- Catalog name
CHIX6B_POSTFKF_BAL
FILEID- File name
FILEID- Catalog file ID
0000008500900bc1.000000.00000036

AGC

1000 AGCGATE- Length of AGC gate (ms)
1.34e8 SFACTOR- Reference scaling factor for scalar computation

GOUT

SEGY FORMAT- Output format
THDRLEN- Trace header length (for WFC4 format only)
PRESTK STKFLG- Pre/post stack header flag (for WGC4 format only)
ASREC TRSORT- Trace sorting code
SEQNO SKEYNAM- Secondary header name

DENSITY- Tape Density Parameters
DENSITY- Output tape density
TAPEOPT- Tape Option Parameters
SYSINFO- Tape processing information
/tapefile=”/disk/staff/sean/chicx/chix6bstkspeq_agc.segy”

SEGY- FOCUS DATA FORMAT (sample file name: DSKRD_TO_DSOUT_6B)

DSKRD

FILE- Disk file name

DSKIO

NAMOFIL- Read Multiple Data Files
PKEYNAM- Primary key header name
FILENAM- Data File name
/ew04_3/chix/focus/chix6b.1.dsk
14336 LENGTH- Data length
Repeats
NAMOFIL- Read Multiple Data Files
PKEYNAM- Primary key header name
FILENAM- Data File name
/ew04_3/chix/focus/chix6b.2.dsk
14336 LENGTH- Data length
Repeats
… repeats to /ew04_3/chix/focus/chix6b.13.dsk

DSOUT

NEW MODE- Create or modify a file (NEW/OVERWRT/APPEND/UPDATE)
AUTO TRORG- Data set format (AUTO/TRACE/VOLUME)
FLT32 ENCODE- Data sample encoding type (FLT32/INT16/INT16100/FLT1)

LABEL-User-defined Label
LABEL- Label
CHIX6b_shots