The `BKNAS' Seismic Data Format Version 1.0

Note: This note summarizes information previously given in AG Notes
      304 and 359.

1. Introduction and a Little History

Seismic data edited at Blacknest were originally written to magnetic
tape as IBM format `master tape' files. The format of the data
contained in these files varied, due to the separate handling of
analogue, digital, broad band, long period and short period array
data over the years, but the data were always written in binary form.

The files had six standard 80 character labels: four tape headers
(VOL, HDR1, HDR2, and a user label), and two trailers (EOF1 and EOF2).
The information contained in these labels was the only concurrent
information available regarding the seismic data contained in the
file. A short description of each of these data formats is given in
section 4.

A new data format was developed for the Digital MicroVax at Blacknest
in the early 1990's. This was the Blacknest raw data format (BKNRW),
again, a binary data format but allowing for a 32000 byte header to
contain array information and so on. The format is described in
section 3.

The Blacknest ASCII format (BKNAS) has since been created to allow
for easy transfer of data between different operating systems at
Blacknest and elsewhere.

IMPORTANT POINT:

The BKNAS format is essentially a super-format, able to describe
all the other edited data formats which have been used at Blacknest
to create master tape files.

In the BKNAS format, the multiplexed seismic data are displayed in
ascii, readable columns, one line per time sample.

Version 2.0 of the BKNAS format was developed to allow external users
access to data contained in the seismic data archive (`robby') at
Blacknest via an automatic data request manager (AutoDRM).
It contains a different header format which excludes all local
parameters. The format of the seismic data is the same as in version
1.0. For more information on this format, consult the Blacknest
AutoDRM documentation.

Version 3.0 of the BKNAS format is currently being developed for the
new in-house digitizer. A description of the new format will be
available when the new system is implemented.

2. The BKNAS Data Format

2.0 Elements of the format

The BKNAS data format is an ascii format and has three basic
structures:

   1. One 80 character `File' card; always present.

   2. Header cards, either:
       i. Three optional 80 character tape header cards, comprising:
          1. HDR1 card, copied directly from the master tape header
          2. HDR2 card, copied directly from the master tape header
          3. User label, an almost direct copy of the master tape
              header

       The three tape header cards are only present in files which
       do not have the full 400 line `BKNAS' header. For information
       on the data formats which use these header cards, see section 4.

        or:

      ii. Optional 400 line, 80 characters per line `BKNAS' header. For
          information on the `BKNAS' header, see section 3.

   3. Lines of data: one line per time sample, one column per channel

2.1 The File card

   The File card format:

        Columns   Format Description

         1-5   A5   Always 'BKNAS', the format type
         7-10   F4.1   Version number of the format, currently 1.0
        12-16   A5   Full station code name as known in-house
        18-19   I2   Number of channels (thus columns) of data
        21-23   I3   Number of lines of header following this one.
                          This is normally 3, except for old BKNRW format
                          input data, where it is 400
        25-27   I3   Number of non-waveform data samples per
                          channel (and thus the number of lines of such
                          data) immediately following the last line of
                          header
        29-35   I7   Total number of samples per channel contained
                          in this file, whether waveform data or not.
                          Thus this field equates to the total number

of lines of data in the file following the
last line of header.

2.2 The tape header cards

   These cards are only present for those files which were originally
   non-BKNRW format master tape files.

   2.2.1 The HDR1 card (80 characters)

      The HDR1 card format:

   Columns Format Description

    1-4   A4   Always 'HDR1'
    5-16   A12   Origin of the data, either:
                   'BKNSTDATCENT' for internal use at Blacknest
                   'BSSPAA.BNST.' for use elsewhere
   17-21   A5   (Original) data type, for instance 'BKNRW',
                   'SDAT', 'AD21', 'WBA'. This field may not
                   necessarily match that in the user label.
                   Use the user label data type in preference.
                   See section 4 for more information.
   22-27   A6   Original number of the master tape on which
                   the file resides
   32-35   A4   Original file number on master tape
   43-44   I2   Last two digits of the year when the original
                   tape file was created
   45-47   I3   Day number of the year when the original tape
                   file was created
   61-80   A20   Comments (rarely used)

   2.2.2 The HDR2 card (80 characters)

      The HDR2 card format:

   Columns Format Description

    1-4   A4   Always 'HDR2'
    6-10   I5   Number of bytes in each data record, e.g.
                   4012 for SDAT data, 4200 for AD21.
   18-80   A63   Comments (rarely used)

   2.2.3 The User Label (80 characters)

      The user label format:

   Columns Format Description

    1-11   A11   Date of the event, in the form 'DD-MMM-YYYY'
   13-20   A8   Time of the event, in the form 'HH:MM:SS'

```
         22-73   A52     Comment. The information here has no fixed
                         format, although it is often as follows:
                         cols 22-63: Epicentre and processing data
                         cols 64-66: Event backbearing (I3)
                         cols 68-71: Event speed (F4.1)
         74-74   A1      One character station code, which should match
                         the full station code given in the file card
                         and also the station code given in the data
         76-80   A5      (Original) data type, for instance 'BKNRW',
                         'SDAT', 'AD21', 'WBA'. This field may not
                         necessarily match that in the HDR1 card. The
                         field here should be used in preference.
```

2.3 The `BKNAS' format header

   See section 3.

2.4 The seismic data

   The seismic data format, one line per time sample, is as follows:

```
      Columns Format  Description
      ------------------------------------------------------------------
       1-1     A1     *One character station code, which should match
                       the full station code given in the file card
                       and also the station code given in the user
                       label.
       2-11    A10    *Date and time of the data sample, in the
                       form 'YDDDHHMMSS', where 'Y' is the year of
                       decade
      12-on   <n>I6   <n> data samples, one per channel. <n> is the
                       number of channels in the data, given in the
                       file card.
```

   * These fields are only present at the start of each original
     data block, and where the information exists in the original
     format (SDAT, DSASP, BSASP, SDLP, ADC4 and WBA, but not BKNRW,
     AD21, BAPPL, ADC1 or ADC2). Where the information is not present,
     the first eleven columns are left blank.

3. The BKNAS Header Format

The BKNAS format is the Blacknest raw, edited data format. A maximum
of 32 channels can be written into one file. The header consists of
400 by 80 character lines, a total of 32000 bytes in all.

IMPORTANT POINT

The line containing the BKNAS information is NOT part of this header.
However, some of the information is repeated in the header for use.

The line formats are as follows:

```
LINE NUMBERS        CONTENTS
------------        --------
1-7                 Array name, array alias, start time, etc.

8                   The tape and file numbers of the first master tape
                    to store this file.

11-25               A copy of the APPLE controlling file (c...stn.dat)
                    can be written here if the data has already been
                    processed.

29-92               Up to 64 lines (2 per channel) containing channel
                    information.

93 onwards          A listing of the poles and zeros for each different
                    instrument number used in recording the digital data
                    followed by blanks to line 400. The format is the
                    instrument number, number of poles, number of zeros,
                    constant and units on the first line followed by the
                    poles (1 line each) followed by the zeros (1 line
                    each). Normally there should be only 1 or 2
                    instrument numbers for a file of digital data.
```

3.1 Line formats in detail

All character data are left justified in their fields, all numeric data
are right justified. The header initially contains blanks. The value
stored in a field if no data are supplied are indicated by "NULL = "
e.g NULL = blanks or NULL = -999.0. Some fields are now redundant and
have not been described here.


```
------
LINE 1
------
```

```
CHAR    FMT   FIELD NAME       DESCRIPTION
-----   ----  ---------------  -------------------------------------------
1-5     A5    Array ID code    Identification code of the array
                               Always present

6-10    A5    Array ID code    2nd identification code of the array
                               Used for the `home' arrays such as
                               EKA, GBA, WRA, YKA, BKN, WOL, FLK, etc
                               Also used to alias IMS codes to ISC codes

11-14   A4    Analogue data    Identification code for an analogue array
              array name       NULL = blanks

15-17         'LAT'
18-25   F8.4  Station          Units = degrees    NULL = -99.0000
              latitude
```

```
26-29        'LONG'
30-38  F9.4  Station          Units = degrees     NULL = -999.0000
             longitude

39-43  I5    Height           Height of station    NULL = blanks
44           'M'              Units = metres

46-48  A3    Current header   This field is always present
             version          Currently = 5.0

50     A1    Start time       Due to technical considerations when
             accurate         digitizing analogue data, the start time
                              given is not the actual start time
                              All analogue data is flagged 'N'
                              However, for digital data the start time
                              is the actual start time and flagged 'Y'
                              except in the circumstance of a digital
                              time error when it is flagged as 'N'
                              Always present
                              (Field repeated at LINE 6, Col.1)

51-80        Blank


------
LINE 2
------

CHAR   FMT   FIELD NAME       DESCRIPTION
-----  ----  --------------   -------------------------------------------
1-8    A8    Event code       Agency, event number, or other code

9-10         'Mb'
11-13  F3.1  Magnitude        Body wave magnitude    NULL = blanks

15-17        'LAT'
18-25  F8.4  Epicentre        Units = degrees     NULL = -99.0000
             latitude

26-29        'LONG'
30-38  F9.4  Epicentre        Units = degrees     NULL = -999.0000
             longitude

39-42  I4    Depth            Depth of event    NULL = blanks
43-44        'KM'             Units = kilometres

45-48  I4    Flinn-Engdahl    From 1995 'F-E Code' standard
             geographic
             region number

49-80  A32   Flinn-Engdahl    Name of the location of the event
             geographic
             region name


------
LINE 3
------

CHAR   FMT   FIELD NAME       DESCRIPTION
```

```
----- ---- --------------- ------------------------------------------
1-11   A11  Event date      Date the event in the form dd-mon-yyyy

14-15       'OT'
17-28  A12  Origin time     Origin time of event (GMT) in the form
                            hh:mm:ss.tt    NULL = blanks

30-31  A2   Code of onset   'AT' = Arrival time as picked by the
                                   seismic analyst
                            'PT' = Picked time as chosen by the
                                   data processor
                            'ET' = Estimated time because either the
                                   event not seen or a problem with
                                   the time code
                            NULL = blanks

33-44  A12  Start time      Start time of event (GMT) in the form
                            hh:mm:ss.tt    NULL = blanks

47-54  A8   Phase           Phase of event    NULL = blanks

55-80       Blank


------
LINE 4
------

CHAR   FMT  FIELD NAME      DESCRIPTION
----- ---- --------------- ------------------------------------------
1      A1   Event type      Type of event detected    NULL = blank
                                C=Mine explosion
                                E=Chemical explosion
                                I=Collapse explosion
                                M=Meteoric explosion
                                N=Nuclear explosion
                                Q=Earthquake
                                R=Rockburst
                                X=Explosion

2      A1   Effect          Event effect    NULL = blank
                                C = Casualties
                                D = Damage
                                F = Felt
                                H = Heard
                                T = Tsunami

1-2    A2   Identifier      Field can be used for other identifiers
                            NULL = blanks

5-7    'BAZ'
8-14   F7.2 Back bearing    Units = degrees     NULL = 999.00
                            Back bearing is defined as the CLOCKWISE
                            angle from the station to the event

17-19  'VEL'
20-25  F6.1 Velocity        Units = Km/second    NULL = 999.0
```

```
28-30 'SLN'
31-36 F6.3  Slowness        Units = Second/degree    NULL = 99.000

39-43 'DELTA'
44-50 F7.2  Angular         Units = degrees    NULL = 999.00
            distance        This is the angle between the event
                            epicentre and the detecting station

51-80       Blank


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LINE 5
------

CHAR   FMT  FIELD NAME       DESCRIPTION
-----  ---- ---------------  -------------------------------------------
1-20   A20  Start time       Start time of the data in the form
                             dd-mmm-yyyy hh:mm:ss    NULL = blanks

21-40  A20  End time         End time of the data in the form
                             dd-mmm-yyyy hh:mm:ss    NULL = blanks

41-48  I8   Total number     Number of channels * sample rate (Hz) *
            of data          Number of minutes of data * 60 (in theory)
            samples          Will vary slightly for analogue data
                             Always present

49-50  I2   Number of        Number of channels of data
            data channels    Always present

51-63       Digitising       Offset time of samples from true digitising
            Offset           rate
                             Usually blank when zero is assumed
                             Units = Seconds

64-80       Comments         Usually blank but may contain information
                             taken from a digitised analogue tape


------
LINE 6
------

CHAR   FMT  FIELD NAME       DESCRIPTION
-----  ---- ---------------  -------------------------------------------
1      A1   Start time       Due to technical considerations when
            accurate         digitizing analogue data, the start time
                             given is not the actual start time
                             All analogue data is flagged 'N'
                             However, for digital data the start time
                             is the actual start time and flagged 'Y'
                             except in the circumstance of a digital
                             time error when it is flagged as 'N'
                             Always present
                             (Field repeated from LINE 1, Col.50)

2-9    A8   Raw data type    Denotes whether the original recording
```

system was ANALOGUE or DIGITAL
                              Always present

10-29 A20 Original   The media the data were ORIGINALLY recorded
            storage media   Possible values are:
                                    ANALOGUE TAPE
                                    DIGITAL TAPE
                                    DIGITAL EXABYTE
                                    AUTODRM
                              Always present

30-40 A11 Processing   Date the data were edited from raw tape
            date   in the form dd-mon-yyyy
                              Always present

41-80   Blank

LINE 7

CHAR   FMT FIELD NAME   DESCRIPTION
----- ---- --------------- --
1-80   A80 Comment   Any user comment   NULL = blanks
                             For old-style digitised analogue and
                             digital tape this field is a copy of
                             the user label

LINE 8

CHAR   FMT FIELD NAME   DESCRIPTION
----- ---- --------------- --
1-6   I6   Original   First tape the data were written
            tape number

8-10   I3   Original   Number of file on this tape
            file number

11-80   Blank

LINES 11-27

A copy of the APPLE controlling file used to generate the BKNAS
header and data can be inserted here up to 16 lines
For a description of this file see either the APPLE subroutine INPUT1
or the read.me file associated with the data

LINES 29-92

```
FORMAT OF THE 2 LINES REQUIRED FOR EACH CHANNEL DIGITIZED OR EXTRACTED
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CHANNEL LINE 1
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CHAR    FMT  FIELD NAME      DESCRIPTION
-----   ---- --------------  ------------------------------------------
1-5     I5   Channel number  Channel number on the raw data tape
                             digitized or extracted
                             Always present

6-11    A6   Pit code        ID of the pit associated with this channel
                             NULL = blank

12-14        'LAT'
16-24   F9.5 Pit latitude    Units = degrees    NULL = -99.00000

25-28        'LONG'
30-39   F10.5 Pit longitude  Units = degrees    NULL = -999.00000

40           'M'
41-47   F7.1 Pit elevation   Units = meters     NULL = -999.0

48           'X'
49-56   F8.3 X coord. pit    Units = km, measured from the centre of
             displacement    the array    NULL = -999.000

57           'Y'
58-65   F8.3 Y coord. pit    Units = km, measured from the centre of
             displacement    the array    NULL = -999.000

66-70   F5.1 Sample rate     Sample rate of the data in samples per
                             second (Hz)
                             Always present

71      A1   Channel sense   `+' indicates POSITIVE DIGITS or POSITIVE
                             VOLTAGE = GROUND MOTION UP/NORTH/EAST
                             `-' indicates POSITIVE DIGITS OR POSITIVE
                             VOLTAGE = GROUND MOTION DOWN/SOUTH/WEST
                             Always present
                             BEWARE (SP 13/7/2009) - Apple ignores this
                             and looks for a sign on "factor" in the
                             following line.

72-80        Blank


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CHANNEL LINE 2
--------------


CHAR    FMT  FIELD NAME      DESCRIPTION
-----   ---- --------------  ------------------------------------------
1-40    A40  Seismometer     Type of seismometer in the pit
```

```
              name            NULL = blanks


41-44  A4    Seismometer     The last letter indicates seismometer
             output          orientation     NULL = blanks
             recorded


50-52  I3    Instrument      Instrument number used to record a channel
             number          NULL = INST 999


53-62  A10   Instrument      Type of data recorded on the raw data
             code            channel    NULL = blanks


63-70 F8.5   Sensitivity     Number by which each sampled value is
             factor          multiplied by to obtain the corresponding
                             ground motion in nanometres
                             This is always a positive number and present
                             The sense of the data comes from the
                             channel sense flag in the previous line
                             Units = nm/bit      NULL = 1.00000
                             THIS IS NOT TRUE (SP 13/7/2009) - give this
                             value the correct sign i.e. -ve if the
                             polarity is inverted.  Apple IGNORES the
                             channel sense in col 71 of the previous
                             line!


71-80        Blank



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LINES 93 onwards
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FORMAT OF THE POLES AND ZEROS SECTION
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POLES and ZEROS LINE 1
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CHAR   FMT  FIELD NAME       DESCRIPTION
-----  ---- ---------------  -------------------------------------------
6-8    I3   Instrument       Instrument number used to record a channel
             number


9-11   I3   Number of poles


12-14  I3   Number of zeros


15-29 E15.4 Poles/zeros      NULL = 0.0000E+00
             constant


30-61  A32  Units of         NULL = blanks
             constant


62-68 F7.3  Calibration      Period in seconds at which sensitivity
             reference       factor (above) is valid     NULL = 1.000
```

```
70-71  I2    Number of sets  If no poles/zeros are inserted this field
             of poles/zeros  is set to zero
                             If there are poles and zeros to insert
                             this field is filled only in the first
                             line of the first pole/zero set

72-80        Blank


-----------------------------------------------
      LINE LISTING A POLE OR ZERO
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Poles are listed first followed by zeros
The poles and zeros are stored as real numbers WITHOUT exponents

CHAR   FMT   FIELD NAME       DESCRIPTION
-----  ----  ---------------  -------------------------------------------
1-16   E16.* X coordinate     X coordinate of a pole or zero

17-32  E16.* Y coordinate     Y coordinate of a pole or zero

33-80        Blank


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Blank lines follow to line 400
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N.B.  Section 4 is not yet available.
```