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| 60 | ***Abstract :*** | The paper disusses the specifications and performance of an eight channel long period seismic digital data acquisition system, which is developed and installed at Seismic Array Station, Gauribidanur, Karnataka State. The paper describes how these data in an unedited form are recorded on a single track of magnetic tape inter-mittantly, which has resulted in recording of 50 days data on a single tapespool. A time indexing technique which enables quick access to any desired portion of a recorded tape is also discussed. Typical examples of long period seismic event signals recorded by this system are also illustrated. Various advantages, the system provides over the analog multichannel instrumentation tape recording system, operating at Seismic Array Station for the last two decades, are also discussed. |
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## LONG PERIOD FIELD SYSTEM

Three element long period seismic network is operating at Seismic Array Station, Gauribidanur, Karnataka State for the last two decades. These three seismometers are situated at the two ends and at the cross over of the L-shaped short period seismometer array (Dimension 22.5 km x 23.75 km). The natural period of these seismometers is 20 seconds and these sensors provide signal bandwidth from about 50 seconds to 5 seconds period. In order to cover higher dynamic range, the high gain (1M) and low gain (100K) signal conditioned outputs from these seismometers are frequency modulated at 2160 Hz and 270 Hz and are cable telemetered to central recording laboratory situated near to cross over point[1].

## ANALOG RECORDING SYSTEM.

At central recording laboratory, the f.m. signals are scaled down to 67.5 Hz carrier and are recorded on separate tracks of a 24 track instrumentation tape deck along with the data from a three component (one vertical,two horizontal) wide band seismometer, different bands of microbarograph signals and a vela time code (pulse repetition rate of 1 pps and 60 second time frame). One central track each of two 12 track head (which are interlaced to form 24 track system) serve as error correction channels to compensate for wow and flutter of tape motion both while recording and reproducing the recorded data.

The tape deck is continuously driven at the tape speed of 0.075 " per second providing packing density of 900 cycles/inch which enables recording of continuous analog data for 12 days on a 15" diameter tape spool with 7200 feet length of tape. The system provides, dynamic range of about 48 dB for the recorded signal.

## DIGITAL DATA RECORDING SYSTEM.

The system which is developed utilizes only seven inputs from above system. They are as follows:

1. Low gain output from L.P.sensor at cross over.

2. Low gain output from L.P.sensor at B10.

3. Low gain output from L.P.sensor at R10 (R10 and B10 are the two extreme points of the 20 element short period seismic array)

4,5,6. Signal conditioned outputs from three component broad band (.025 Hz to 25 Hz aprox.) seismometers situated near to cross over point.

7. Additional vertical broad band seismometer situated at cross over point. This is an experimental channel and shall be replaced by a signal conditioned output from a L.P.sensor situated at cross over with a gain of -20 db with respect to low gain output from the same sensor. This is to ensure recording of unsaturated signal, arising from large magnitude events and thus enhancing the overall dynamic range of the system.

8. The eighth channel is occupied by time code. The time code which is specially designed for this system has a pulse repetition rate of one pulse every ten seconds and time information in BCD format for the day of the year, hours, minutes and year, is encoded in sixty ten second pulses in a time frame of ten minutes. The time code is illustrated in Fig.1.

## SYSTEM DESCRIPTION

The block diagram of the recording system is illustrated in Fig.2. The 8 channel analog data is fed to a 8 channel analog multiplexer, through individual voltage followers. The multiplexed data is given to an ADC which provides 12 bit

resolution with conversion time of 50 microsec. The timing system provides necessary timing pulses to carry out digital conversion for all 8 channels once in every 500 milliseconds. The 12 bit digital data is stored serially in either bank A or bank B of a memory unit with a capacity of total 64K words. Each of the bank provides memory of 4K words per channel, which means that the data corresponding to 2048 seconds (about 34 minutes duration) is sequentially stored in each bank of the memory.

When a bank of memory is completely filled with data, another bank is chosen for inputting the data from ADC. The data already stored in other bank is transferred to the magnetic tape. A four track professional audio tape deck (Teac make X-2000R) which provides recording of data in forward and reverse mode, is used. Total 6 head system (erase, record and replay in forward and reverse mode) is utilized. This enables, simultaneous recording and reading of recorded data through separate write and read heads in both forward and reverse directions. At a tape speed of 3 3/4" per second, the deck provides response upto 22 kHz which enables the recording of digital data at around 19,000 baud rate using biphase encoding technique.

For transferring data to the tape from a memory bank, the digital data words are sequentially fed to a parallel to serial shift register at a rate of 1600 words/second. The serial NRZ data is then biphase encoded. The necessary timing pulses, clock pulses, memory addresses, etc., are generated in the timing system. The serial biphase encoded data is given to a tape interface circuitry where the square pulses are converted into sinusidual waveforms without introducing any phase distortion in the band of the signal.

As soon as the bank of memory becomes full, a control signal is given to provide power to the tape deck, which is preprogrammed to drive the tape in record mode. At rate of 1600 words/second rate, the bank of memory of 32K words is transferred in about 20.48 seconds. The deck is driven for another half

second to generate a record gap. In short the data of total 34 minutes duration stored in a bank of memory is transferred to a magnetic tape in about 21 seconds. The data is thus compressed about 100 times in time scale. The tape deck is then switched off, till the data from the other bank of memory is ready to be inputted. The tape deck is thus operated intermittently.

The data in bank can also be verified at regular interval during the period of 34 minutes. After every 64 seconds, the data from the bank is serially read through biphase decoder, serial to parallel converter, a DAC and demultiplexer circuitry, which provides parallel analog output. In case the recording on the tape was not possible (due to mains power failure or due to any other difficulties) immediately after a bank of memory is completely loaded with data, the recording on the tape can be subsequently carried out at 64 second pulse with manual trigger control to power the tape deck.

Considering recording on all four tracks (mono operation) one after another, at tape speed of 3 3/4"/second and with 3600 feet length of a tape, about 50 days of unedited data can be stored in a single spool of a magnetic tape.

All the D.C.supplies of the system are provided with battery back up facility. This is very necessary since in the event of power failure,the data in the memory bank can be lost.

Detail specifications of entire data acquisition system are provided in appendix.

TIME INDEXING SYSTEM.

In each record block of 34 minute duration, at least two full time frames ( 10 minutes duration) of time code are recorded. As said earlier, the data when transferred to tape from memory bank, gets compressed 100 times in time scale. When data is read from the tape, it is also read at 100 times the real time

acquisition rate. So also the time code frame gets reduce from 10 minutes to 6 seconds. The time code reader thus decodes and displays the time information in six seconds when it reads a full time frame.

With the aid of this quick time scanning facility any desired portion of the tape can be searched quickly. The data recorded in compressed mode also facilitates replay of any event with duration of two to three hours, in couple of minutes. In fact the data for 24 hours duration can be replayed in about 16 minutes.

As in the case of short period event data recording system[2], this L.P data acquisition system also provide parallel digital port for data either read from the tape or from memory bank in online mode. This port can be interfaced to any microcomputer system.

As compared to the multichannel analog recording system, this system is much compact, portable and provides much higher dynamic range for the recorded signals. The capital cost of the new digital system could be around 10% of the analog system. The analog system also records few additional data channels from microbarograph array. The new system can be suitably amended to record the data from these additional channels.

Few of the long period seismic events recorded by the system are illustrated in Fig. 3 to 6.

## CONCLUSION.

The system acquires unedited eight channel long period seismic data. Due to 100 times speed up operation of acquired data, vast amount of this data can be handled quickly and effectively. It is hoped that the new system shall fulfill this requirement of upgradation for the existing analog system since it provides definite superiority in terms of higher dynamic

range, quick accessibility to any portion data, easy computer interface,etc. The new system is also very compact and costs 10 times less.

## ACKNOWLEDGMENT.

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1. Suryavanshi M P "The long period seismic system at Gauribidanur" BARC report 1103-1981.

2. Kolvankar V G "Operational Performance of a multichannel seismic event data acquisition system." BARC report under printing.

## APPENDIX

### SPECIFICATIONS.

| | |
|---|---|
| Input channels | : Seven seismic (Bandwidth DC to 0.4Hz), a time code (a pulse every 10 sec.,10 minute time frame,encoded information - day of the year,hours,minutes,year). |
| Digital Conversion Rate: | 2 samples/chan/sec. |
| Word Length | : 12 Bits. |
| Input Data Rate. | : 16 samples/sec. |
| Memory | : Total memory capacity is 64K words divided in two banks,alternately used for storing data and transferring it to mag.tape. |
| Code used for Recording: | Manchester. |
| Tape Recorder used. | : Teac make X-2000R.This is a four track,mono/stereo,autoreverse type with 3 head system,accepts 10 1/2" spool,two tape-speed and facilitates remote operation. |
| Operating Tape speed. | : 3 3/4"/sec. |
| Through put rate | : 1600 words/second. |
| Error bit rate. | : Better than 1 in 10^6. |
| Total tape capacity. | : 69.12 M words (3600 feet length) unedited data corresponding to 50 days |

can be stored on single tape spool of 3600 feet length.

Tape packing density. : 5120 bits/inch/track (usable data).

Reproduced Electronics provide following outputs.

Analog output : provides multichannel analog data.

Digital output : 12 bit parallel words with channels address.

Both these outputs provide data which is 100 time compressed in time scale.

Power supplies. : + 5 volt,at 1.5 Amp.
+ 7.5 volts,at 0.5 Amp
- 7.5 volts at 0.5 Amp.
All these supplies are provided with battery back-up.

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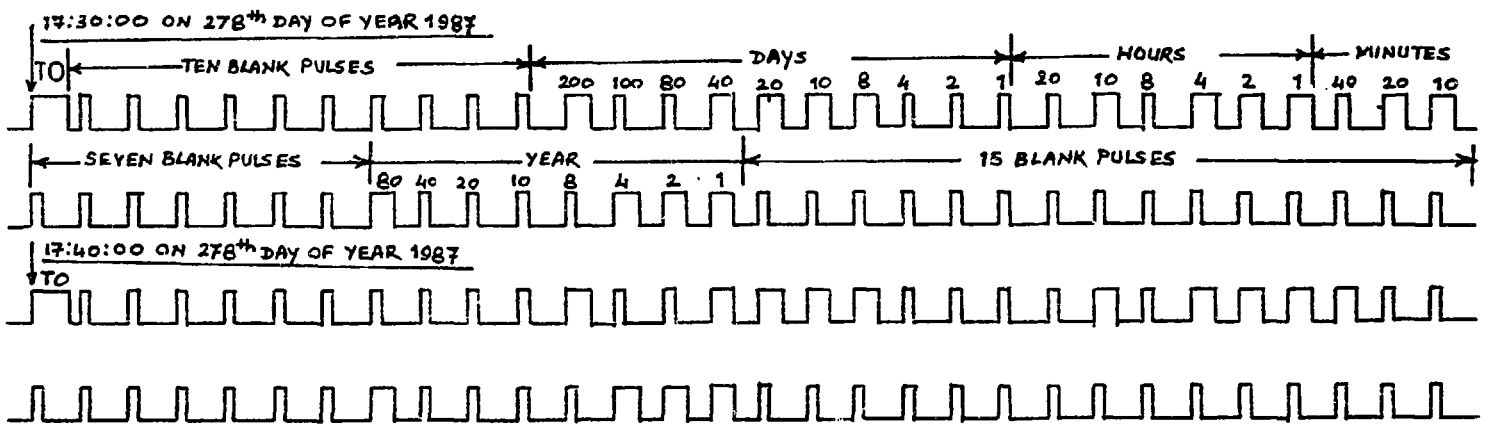



TO = START OF TIME FRAME = 8·0 SEC.

BINARY CODE DECIMAL BITS 'ONE' = 5·0 SEC. ZERO = 2.0 SEC.

UNUSED BITS = 2·0 SECS.

CLOCK RATE = 1 PULSE/10 SEC.

TIME FRAME = 10 MIN.

Fig.1. **ILLUSTRATION OF TIME CODE II**

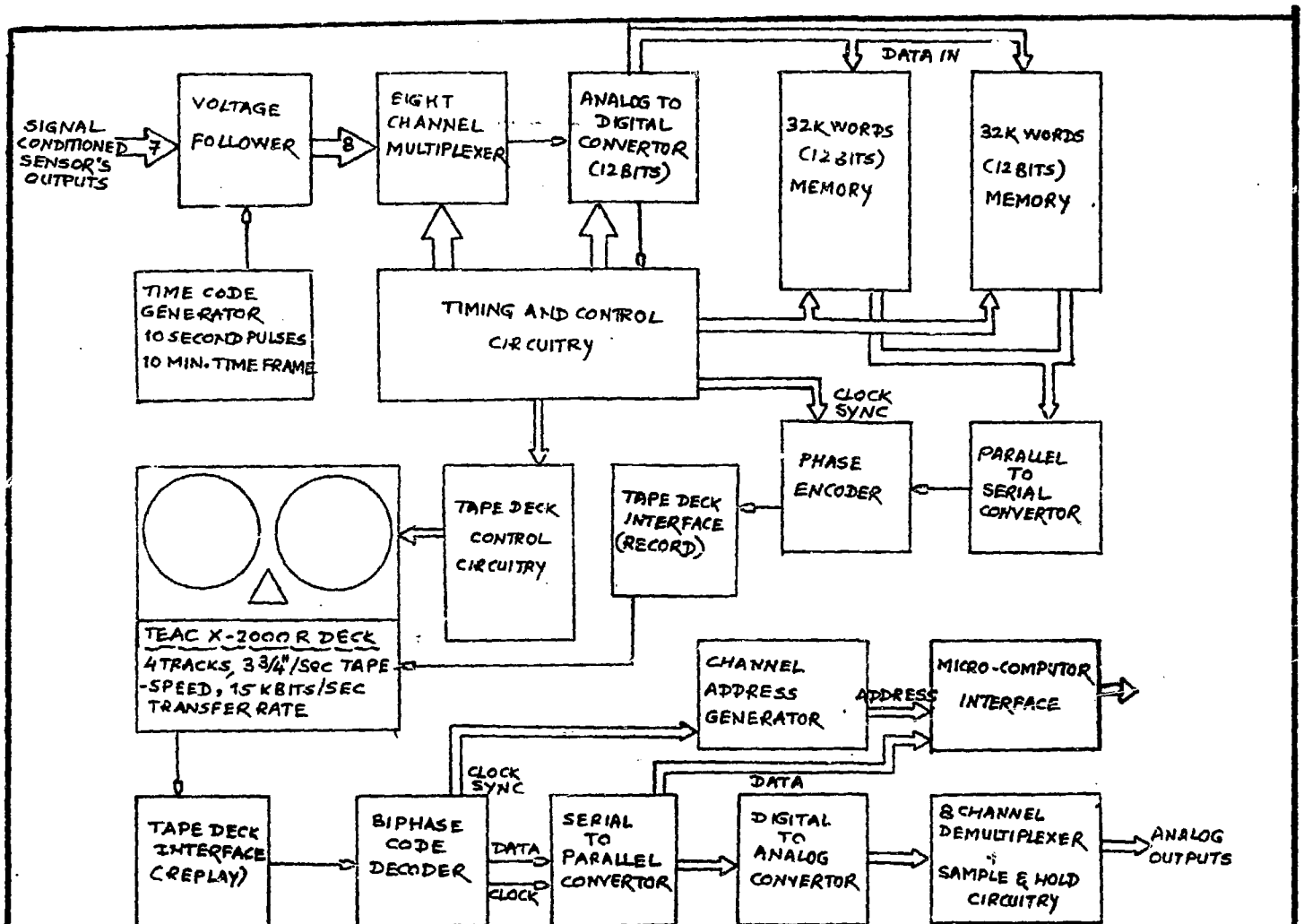



Fig. 2.

**BLOCK DIAGRAM - SEISMIC LONG PERIOD DATA ACQUISITION SYSTEM**

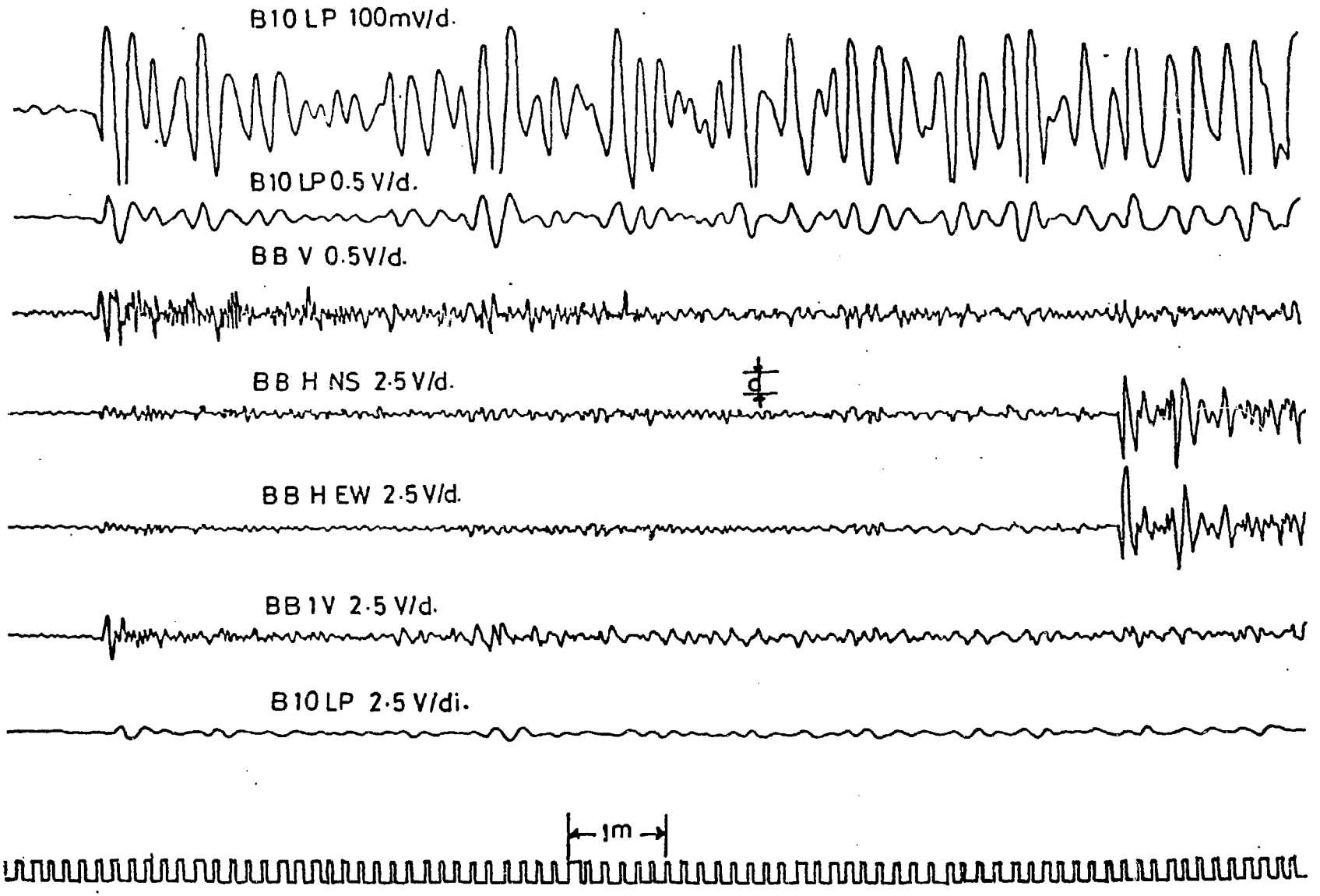
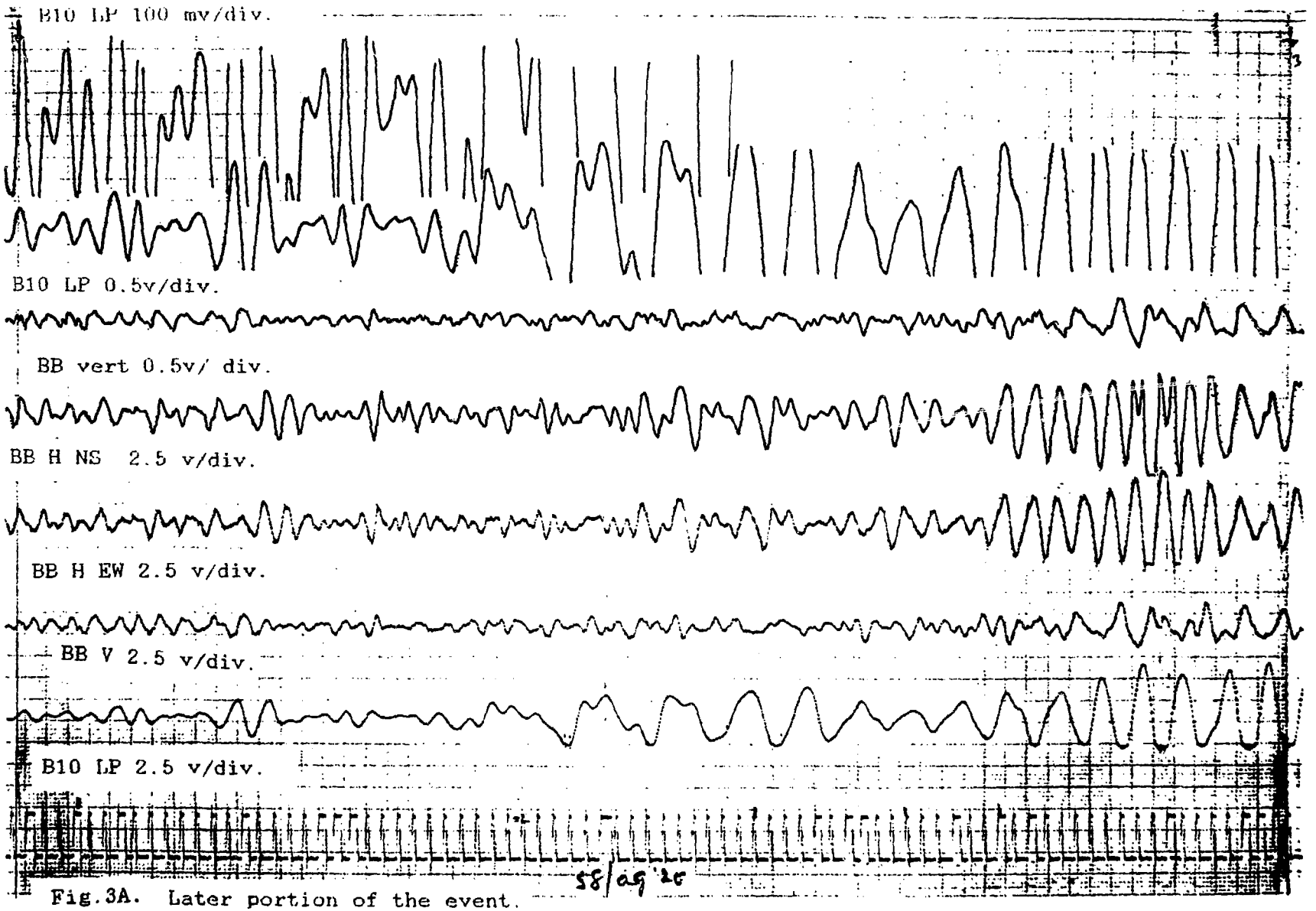



Fig.3. A long period event with onset time at GBA of 08:45:10 on 27 th Feb. 1987. Origin time being 08:31:53.4, located at Lat = 53.47 N, Log = 167.2 W, Mb = 6.2 Fox Island, Allution Island region.




58/aq'20

Fig.3A. Later portion of the event.

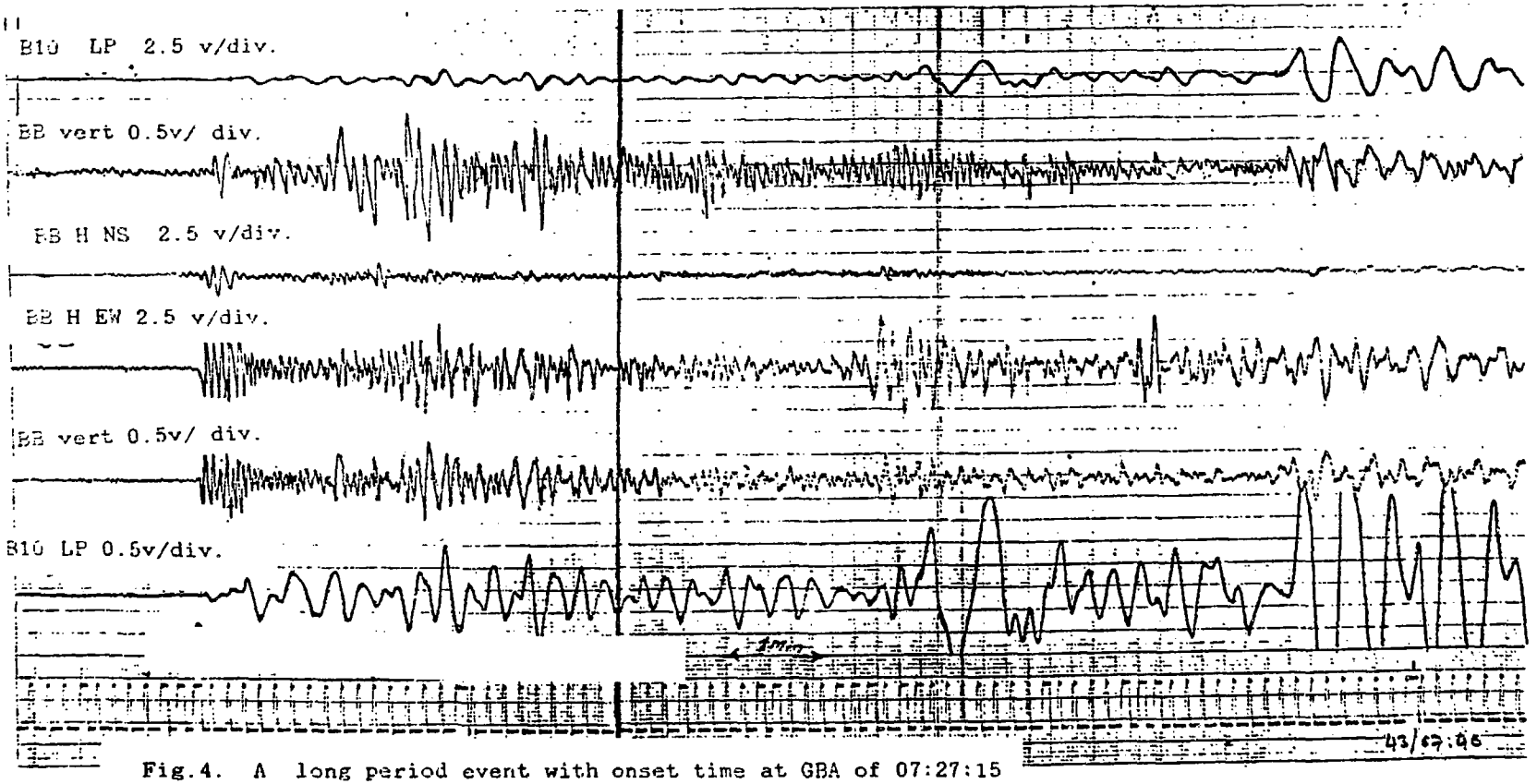



**Fig.4.** A long period event with onset time at GBA of 07:27:15 on 13th Feb. 1987. Origin time being 07:18:29, located at Lat = 0.67 N, Log = 126.1 E, Mb = 6.2 Mollucca Passage. In the clock, the days were wrongly set at 43 insted of 44.

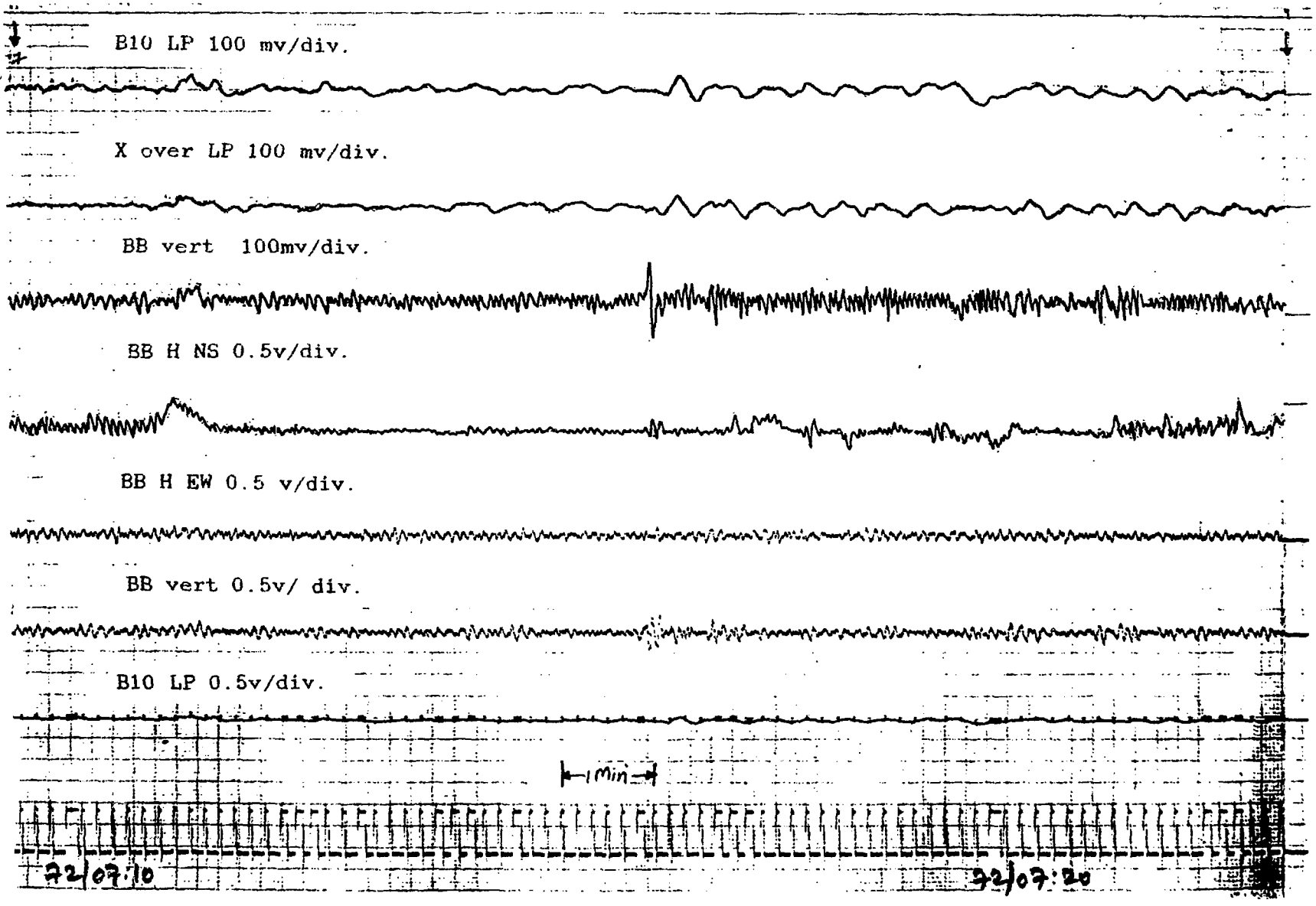



Fig.5. A long period event with onset time at GBA of 07:16:10 on 13th March 1987. Origin time being 06:56:32.8, located at Lat = 12.3 N, Log = 87.4 W, Mb = 5.1, Near coast of Nicargua.

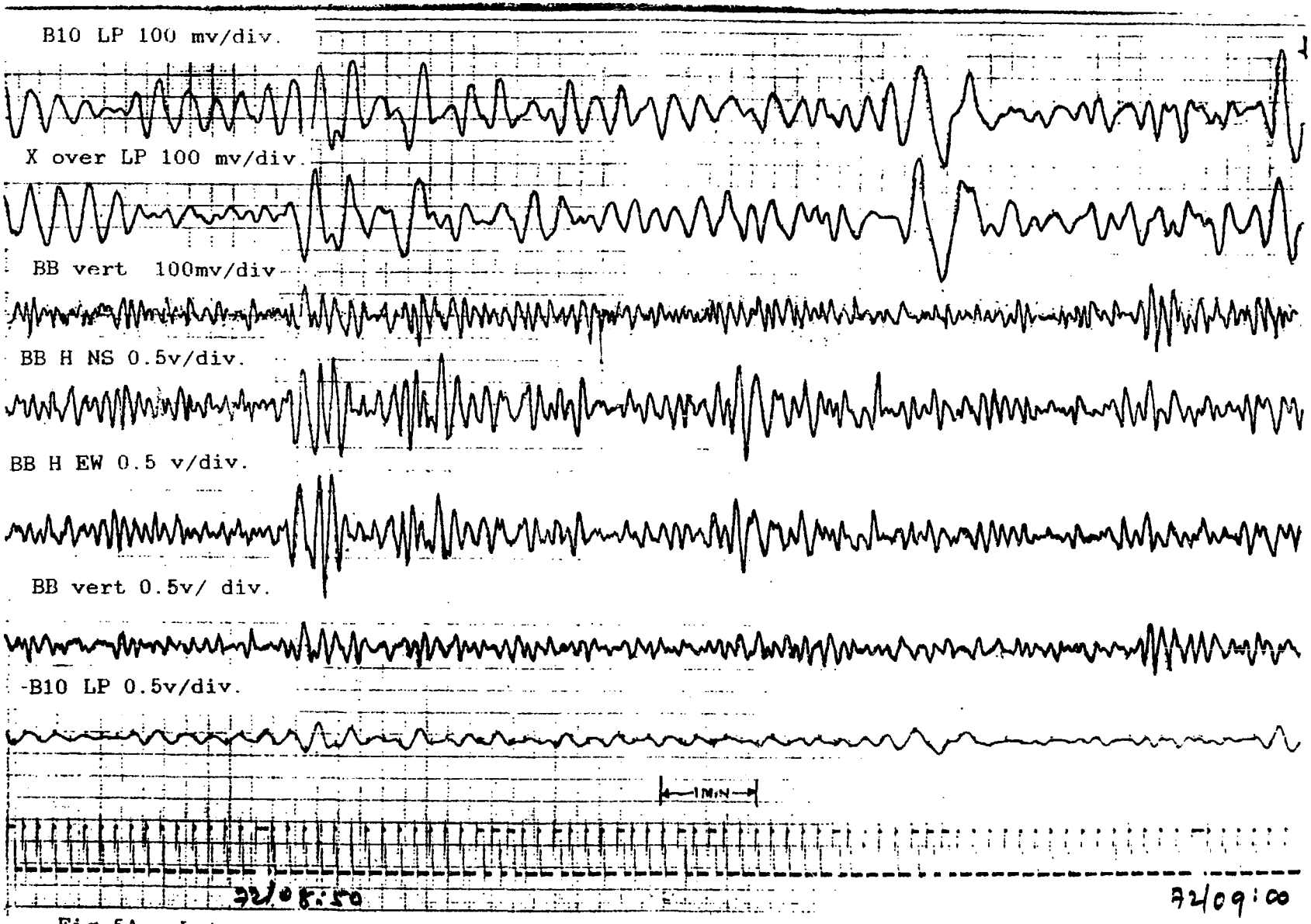



Fig.5A. Later portion of the event.

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