NOTE ON NNSS AND LORAN C

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1. Positioning and data acquisition

On this cruise the NNSS system and Loran C receiver were applied to fix the positions and to navigate. NNSS was mainly used and Loran C was used as an auxiliary.

The operation and data logging for NNSS and other digitized data were as follows.

1) For the velocity sensor EM-log was mainly applied. The area of study does not have a wide continental shelf so the velocity sensor is not frequently used the doppler sonar on the bottom lock mode.

2) Several kinds of digital data were recorded or logged on the time intervals as follows.

a. navigation data .....MT (digital magnetic tape) of NNSS ..... every 30 sec
b. navigation data .....Printer (Silent Printer) ..... every 5 min.
c. gravity data .....MT of NNSS ..... every 10 sec
d. gravity data .....MT of Gravity meter ..... every 10 sec
e. processed gravity .....TTY (tele-typewriter) of NNSS ..... every 10 min.
f. measuring of Proton Magnetometer .....MT of NNSS ..... measuring every 6 sec, the logging is the same as navigation data of every 30 sec

2. Loran C

The receiver of Loran C is an LR-3Z1 manufactured by Furuno Electric Co. This is a fully automatic and electronic tracking system and keeps good accuracy and dependability. Loran C data are not logged, however, on the NNSS data logger. The outputs of Loran C are recorded on the XY plotter as analog quantities. This plotter is not only an analog but approximates the Loran C lane as a linear quantity, so there is a difficulty in keeping accuracy of the original data. It remains to solve the problems of logging and accuracy. Currently Loran C is applied both to auxiliary use and relative position tracking for drifting in the sea bottom sampling.

During this cruise the SS3 chain (the West Pacific Ocean) of Loran C was applied, in which the master station is Iwo-Jima Island and the slave stations are Okinawa for X lanes and Hokkaido for Y lanes.

The tracking charts were plotted by the plotter on a scale of 1 : 500,000 for cruising and 1 : 100,000 for drifting.

The Loran track chart is shown in Fig. 7 as an example. Plot interval is every 1 min., and the scale of the original chart is 1 : 500,000. There were no trouble with the operation of the Loran C receiver except for one lave slip.

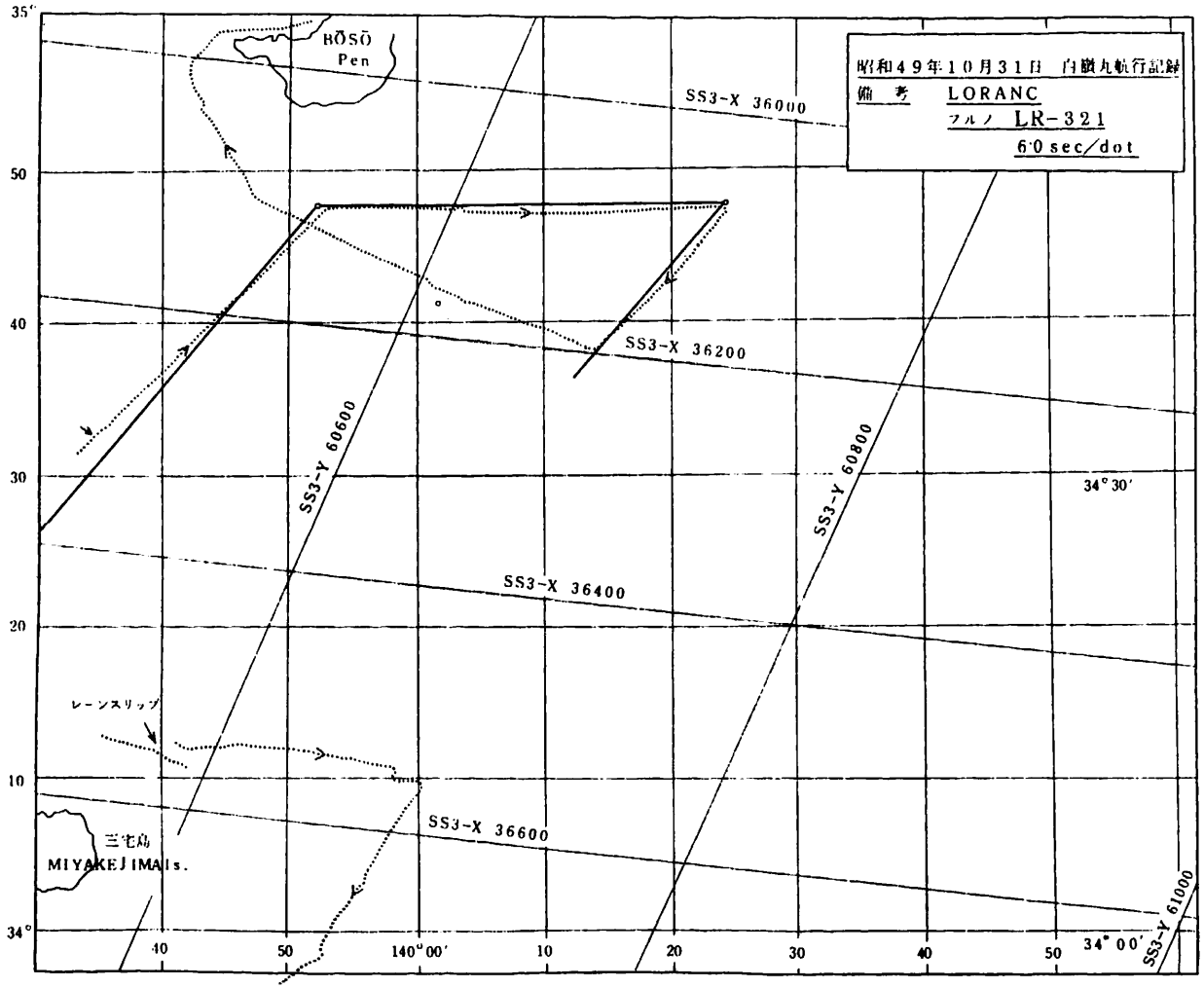

Fig. 7 Loran C record example. The outputs of time differences with an accuracy of 0.1 micro-sec plotted on the analog XY plotter on the original scale of 1: 500,000. The plotting interval is 1 minute.

3. CRT display of NNSS

The practical application of the CRT (Cathod Ray Tube) display of NNSS (Navy Navigation Satellite System) is reported in this section. Fig. 8 shows the appearance of the NNSS system with the CRT monitor at the top of the right console. The CRT display is used for real-time data monition. The display type is 16 characters for the horizontal (scanning) direction and 8 lanes for the vertical one. One character is formed by 35 dot elements, 5 elements for the horizontal direction and 7 for the vertical one.

Four sets of CRT monitors are installed near the NNSS main equipment for the operators, in the chart-room for the navigators, in the first laboratory for the geophysicists and in the fourth laboratory for the geologists. The display contents are of 4 types as follows.

1) Navigation real-time information
   - 1a. Navigation data
   - 1b. Running to the aim point
2) Display of memories
   - 2a. Binary display
   - 2b. Floating point display

Fig. 9 shows the navigation data, type 1a.

The definitions of every data are given as following and the instruction words are explained in parenthesis.

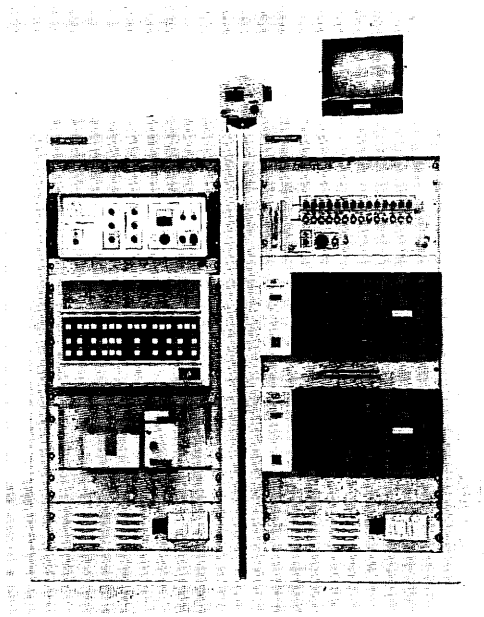

Fig. 8 The consoles of NNSS. The left console consists of the satellite receiver MX-702A-3, the mini-computer HP2100A with 12 k-words and the paper tape photo-reader. The right console consists of the 200 model for geophysical use with two sets of magnetic tape. DTIME BOX is situated on the topcenter of consoles and CRT is situated to the right.

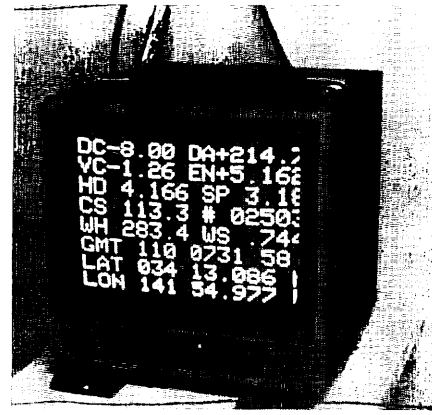

Fig. 9 CRT display of navigation data. Real-time navigation data illustrated on the CRT.

DC (DCC: distance cross course)
Current distance from the survey line in kilometers. Off course starboard DCC will be positive and off course port DCC will be negative.
DA (DAC: distance along course)
Current distance along the survey line in kilometers. If ship is behind the survey line then DAC will be negative.
VC (velocity cross course)
Velocity component toward the survey line in knots. The starboard side is positive and the port side is negative.
EN (END: distance to end point)
Current distance of the ship to the end of the survey line in kilometers. If the ship passed over the survey line then END will be negative.
HD (HDG: heading)
Current ships heading from the gyrocompass shown in degrees between 0 to 360 degrees.
SP (SPD: speed)
Current speed of the ship in knots. If sonar is in bottom lock, this parameter is only the speed measured by the sonar. If the sonar is in water track this parameter is the speed measured by the sonar added to the speed calculated from the water speed (WSPD) and water heading (WHDG) parameters manually entered at NNSS initialization. If the speed type is used in EM log it will be the EM log speed added to water heading and water speed. If the speed type being used is MSPD it will be the manual speed and heading entered added to the water speed and heading.
CS (course)
Azimth of the survey line.
(shot number)
Some counting number. Its interval is determined by both number of instruction TOUT and set number of DTIME BOX. It is used for the automatic air-gun control and others.
WH (WHDG: water heading)
Seen next item.

WS (WSPD: water speed)
Water speed and heading used in the fix computation if the sonar was in water track. Not used if the sonar was in the bottom lock. On the bottom lock this display is erased but these were kept in the memories.
GMT (DAY and TIME: Greenwich mean time)
Julian calendar day Greenwich Mean Time are shown in hour, minute and second.
LAT (LAT: Latitude)
It means the latitude, the starting 3 digits are degrees and last 5 digits are minutes. When it entered from the printer, North and South Hemispheres are represented by N and S, and no sign enters to N.
LON (LON: Longitude)
It means the longitude. The units are the same as the upper item. E and W are used for East and West Hemispheres and no sign is E.

Remark: All instructions are formed of four characters and if it is less than three the space shift is added.

When the ship runs to the aim point, which is set before the starting point of the survey line, the instruction SAIL is used. In this 1b. stage the navigation display and little different display are shown alternatively on the CRT, in which DA is changed to R which stands for Range and means the range to the aim point from the current ship position. EN is changed to B which stands for bearing and means direction of the aim point. Other data are the same. The alternating is seconds already designated.

Other usages of CRT are to check the memories of the computer HP 2100A. It is also available to check the memories and diagnostics of mulfunction. This instruction is DIAG. DIAG is typed in from the printer then the printer types INPUT ADDRESS out. The operator then enters the address in octal of the start of the 8 parameter block wanted and types CR and LF (carriage return and line feed). The program types BINARY? on the printer. When YES is typed, the memory contents of 8 addresses are shown in 16 bits by

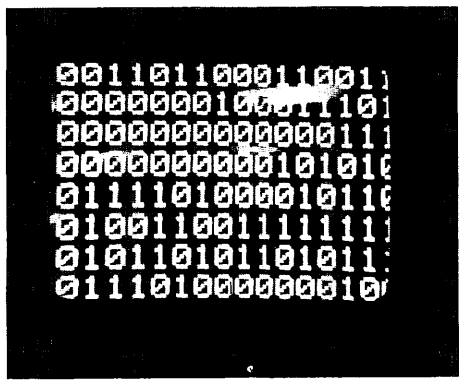

Fig. 10 CRT display of DIAG in binary form. The computer memories are displayed which show memories' contents of 8 words of 8 addresses starting from the designated address in 16 bits.

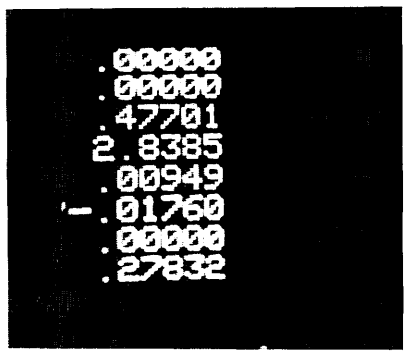

Fig. 11 CRT display of DIAG in floating point. 8 floating point number forms are shown and 1 word is formed by 2 address.

1 or 0. Fig. 9 is an example of the BINARY display by DIAG. The address is represented by the octal and when the operator uses 8 and 9 by mistake, the computer changes them to 7.

When the operator needs the floating form, it is typed as NO. Fig. 11 is an example of the floating form. One number uses two addresses for the floating points. One word consists of 16 bits; the 0th bit being the lowest and the 15th bit being the highest. The fractional part is formed that the 15th bit is sign and the 14th bit of the 1st word through the 0th bit to the 8th of the 2nd word. Then the fractional part is formed of 24 bits including the sign. The point is always put at between the 15th and 14th bits. The exponent part is formed of 8 bits and starts from the 7th bit of the 2nd word and the 0th bit is the sign.

The floating point representation uses 16 addresses for 8 numbers. The floating point number uses 2 addresses and then some numbers do not always have physical meanings.

When the DIAG display is wished to be restored to navigation data, the instruction NCRT (no CRT display) is used.

The DIAG display is very convenient in checking the memory contents and to study the system.