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TECHNICAL MEMORANDUM NO. 4-75

ALVIN GYROCOMPASS
PERFORMANCE REPORT
5 JUNE 1974 TO 15 SEPTEMBER 1974

D. S. Hosom and J. D. Donnelly

May 1975

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WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts 02543

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prepared by

D. S. Hosom

J. D. Donnelly

DATA LIBRARY & ARCHIVES
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Introduction

This report documents the performance of two gyrocompasses used on ALVIN between 5 June and 15 Sept., 1974. During this period ALVIN participated in Project FAMOUS and completed a series of dives on the New England Sea Mounts.

A GyroSystems, Inc., Model 800 gyrocompass was used from June 5th until August 9th. A Sperry Marine Systems Company subminiature gyrocompass was used from August 9 through September 15. The Sperry and GyroSystems compasses provided an accuracy within several degrees when compared to the ship's compass. The data does not represent a controlled evaluation since it was impossible to take readings simultaneously on ALVIN's and the support ship's compasses. Therefore this report should be considered as an at sea operational evaluation. Within the limitations of the evaluation and using the method described for calculating "offset" and "average error" the following summary comparison can be made. The Sperry gyrocompass had an average error of about 1.4° . The GyroSystems Model 800 had an average error of 4.6° .

General

The FAMOUS Project consisted of 17 dives in and around the Rift Valley and Fracture Zone of the Mid-Atlantic Ridge near Ponta Delgada, Azores. The area under investigation was in near proximity to newly formed earth crust with strong and

highly variable magnetic properties. The standard magnesyn compass used on ALVIN provides adequate operational heading information in most under sea environments, however, magnetic heading is totally unreliable in areas of magnetic anomalies such as the Mid-Atlantic Ridge. A reliable gyrocompass was therefore critical for obtaining accurate heading data. A continuous record of various parameters, including heading, was also needed for later correlation with samples and pictures. It is not feasible to record heading from the magnesyn but is feasible with the gyrocompass. Standard synchro to digital and digital to analog circuit modules are used to provide both digital and analog signals for recording.

The FAMOUS Project was followed by a series of dives on the New England Sea Mounts. Although the problem of magnetic anomalies was not as critical during these dives, heading was desired to a greater accuracy than possible using the magnesyn compass.

Figure 1 is the schematic for the 30 vdc to 24 vdc regulator which was used to provide power to both compasses. This regulator insures that the compass is never subjected to an over voltage.

Sperry Marine Systems Inc. - Subminiature Gyrocompass

Specifications

Weight - 16.5#

Power - 24v dc - 75 w start

35 w run

Angular Freedom - + 40° pitch, unlimited roll

Settling Time - 4 hr. (unaided)

Size - 7" x 7" x 10" complete

The prototype miniature compass was loaned to the Woods Hole Oceanographic Institution by Sperry Marine System Inc. The Institution assumed the cost of preparing the compass for use and installing a readout synchro. Since a 400 hertz excitation was not available in the compass, an external supply was used.

After installation on KNORR, periodic checks were made of the subminiature compass heading and the R/V KNORR compass heading. R/V KNORR has two Sperry MK 37 Gyrocompasses as ship equipment. Tables 1 and 2 show the results of the checks. In Ponta Delgada, Azores, the compass was turned off and installed in the electronics van aboard the R/V LULU. R/V LULU has a Sperry MK 14 gyrocompass as ship's equipment. After installation on R/V LULU, the compass was energized and checks continued. After Leg 3 of Project FAMOUS, the Sperry gyrocompass was installed in ALVIN for the New England Sea Mount dives and also for two cruises south of

of Woods Hole. During the time the compass was installed in ALVIN the brush recorder was used to record heading.

Table 2 gives the comparison data on the Sperry subminiature gyrocompass. The date, dive number and/or time is noted for each reading, with ships compass reading as the reference plus the Sperry subminiature compass reading. All readings were taken with ALVIN on deck of R/V LULU. Since there could be some offset due to mounting or alignment, an "offset" is calculated to be the average of the corrections, where correction is the ship heading minus the Sperry compass heading. This offset is then subtracted from each correction to obtain a "net correction." The average magnitude of the net correction is called average error. The offset and average error are computed separately for the time on R/V KNORR, R/V LULU, ET Van, and ALVIN. On R/V KNORR the reference gyro was a Sperry MK37 gyrocompass and the offset was nearly zero, the average error was 0.16° and the maximum peak to peak error was 1° . In the R/V LULU ET Van where the reference was the R/V LULU Sperry MK14 gyrocompass, the offset was 2.8° , average error was 1.3° and peak to peak maximum was 8° . In ALVIN, with the same MK14 compass reference, the offset was 1° , average error was 1.45° and the peak to peak maximum error was 5° . This seems to indicate that the Sperry subminiature gyrocompass is nearly as good as a Sperry MK37 and better than the MK14. The MK14 was probably the major contributor to error calculated aboard R/V LULU.

Figure 2 shows a typical heading record while ALVIN was on the deck of R/V LULU. The time scale was 1 minute per division and the amplitude scale was 7.2° per division. The record records the sea motion which was experienced on R/V LULU and reflected in heading variation. Figure 3 shows a record taken during a dive on a sea mount. The digitizing steps are visible in some traces plus the effect of the multipoint recorder sampling during rapid heading change. The time scale is 5 divisions equals one minute and 7.2° equals one division. The smooth record obtained represents the actual heading during all dives.

The Sperry subminiature gyrocompass performed throughout the entire operational period as a reliable, accurate heading reference. The turn-on procedures are simple and the compass is not sensitive to momentary power interruptions. After the operational period a factory evaluation was made and there was no change in any gyro parameters during the time. The data taken and the operational experience obtained during this period show this compass to be a fine, dependable instrument.

Sperry Gyro Log - Notes

Table 1

5 June 1974 1700	Sperry secured to bench in main lab aboard KNORR. Wired to power supply at 27.0 volts. Power switch to start slewed to heading 030.
5 June 1974 1706	Shifted to run position leveled element according to instructions, energized follow-up.
5 June 1974 1800	Underway enroute to Ponta Delgada, Azores. Periodic checks against KNORR master gyro (Sperry MK37) indicates settling is not complete.
5 June 1974 1945	Learned that KNORR has shifted to #2 gyro (also Sperry MK37). Agreement is within 1/2 degree.
8 June 1974 0930	Making preparations to put output into brush paper tape recorder. Connected synchro output lead of Sperry to synchro to analog box. Brush recorder indicates 095° which is ship's heading. Unbolted Sperry from bench. Rotated to give heading 000° brush did not follow. No voltage at synchro output terminals. R ₁ R ₂ should have 26 v 400 current. Bolted compass to bench, ship's head 095°, Sperry reads 045°.
13 June 1974	On advice from Hosom, brought 400 cycle inverter to bench and energized synchro rotor. Connections to gyrosync repeater ABCDE - R ₂ R ₁ S ₂ S ₁ S ₃ respectively. Repeater indicates correct heading 095° and moves in proper direction with ship's yaw.
14 June 1974	Removed 400 cycle supply and repeater - continue to run gyro on bench - following KNORR's compass.
18 June 1974	Shut down at 1000 November Time Zone for relocation to LULU. Run was normal and closely followed KNORR's compass. Relatively little pitching during trip but rolling up to 30° Port and Starboard.

July 31 1045 Tied in Port.

" " 1335 In Tow to Dive Site.

Aug 2 1620 In Tow - Calm.

Aug 3 1130 Drifting during Dive.

Aug 3 1720 After Recovery (Rough)

Aug 4 1315 During Dive Drift (Calm)

Aug 5 1229 During Dive Drift (Calm)

Aug 6 1218 During Dive Drift (Calm)

" " 1808 After Recovery (Calm)

Aug 7 1854 During Transponder Rec.

" " 1922 During CW Turn

Aug 8 1327 Under Tow

Aug 9 0958 Under Tow

Sperry Gyro Data

Table 2

<u>Date</u> <u>1974</u>	Dive	Time	Ship KNORR	Sperry on Bench	Correction	Net Correction
6/5			95	95	0	0
6/6		1400	109.5	110	-.5	-.5
6/7			107.5	108	-.5	-.5
6/8		0800	96.5	97	-.5	-.5
		1040	95	95	0	0
		1135	95	96	-1	-1
			95	95	0	0
6/9			97	97	0	0
6/10			95	95	0	0
6/11			100	100	0	0
6/12			97	97	0	0
6/13			95	95	0	0
6/14			97	97	0	0
6/15			98	98	0	0
6/16			95	95	0	0
6/17			95	95	0	0
					<u>0</u>	<u>0</u>
					Offset 0	Avg - 0.16 ^o

LULU

Sperry
in ET Van

7/31	1335	176	180	-4	-1.2
	1345	171	175	-4	-1.2
	1400	255	259	-4	-1.2
	1425	251	253	-2	.8
8/2	1620	222	224	-2	.8
8/3	1130	189	191	-2	.8
	1223	138	135	+3	5.8
	1310	232	230	+2	4.8
	1345	176	179	-3	-.2
	1545	265	267	-2	.8
	1720	200	205	-5	-2.2
	1820	217	220	-3	-.2
	1837	220	222	-2	.8

Date	Dive	Time	Ship	Sperry in ET Van	Correction	Net Correction
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8/4		1315	241	243	-2	.8
		1451	226	228	-2	.8
		1531	018	020	-2	.8
		1707	137	140	-3	-.2
8/5		1229	261	262	-1	1.8
		1338	250	252	-2	.8
		1545	315	317	-2	.8
		1613	313	315	-2	.8
8/6		1218	225	228	-3	-.2
		1517	302	305	-3	-.2
		1543	168	171	-3	-.2
		1808	103	107	-4	-1.2
8/7		1854	195	199	-4	-1.2
		1922	200	205	-5	-2.2
8/8		1327	075	080	-5	-2.2
		1607	077	082	-5	-2.2
		1806	074	078	-4	-1.2
8/9		0958	076	081	-5	-2.2
		1412	070	075	-5	-2.2

Offset -2.8° Avg - 1.30°

Sperry in
ALVIN

8/16	536		164	168	-4	-3.1
8/21	537		110	114	-4	-3.1
8/24	538		126	128	-2	-1.1
8/25	539		314	314	0	.9
8/27	540		132	132	0	.9
8/28	541		342	341	+1	1.9
8/30	542		057	060	-3	-2.1
9/1	543		339	338	+1	1.9
9/18	544		000	001	-1	-.1
9/19	545		357	357	0	.9
9/20			146	145	+1	1.9
10/3			312	313	-1	-.1
10/5	546		083	083	0	.9

Offset= -.9 Avg - 1.45°

Gyrosystems Inc. - Model 800 Gyrocompass

Specifications

Weight - 10 lbs.

Power - 24 v DC. 60 w. start, 30 w run

Angular Freedom - $\pm 40^\circ$ Tilt

Settling Time - 30 min.

Size - 4 1/2 x 4 1/2 x 7" h. sensor

5" x 5 1/2" x 4 1/2" h. control unit.

The Model 800 gyrocompass was purchased in October 1972 and installed in ALVIN in April 1973. At this time there were several compass electronic failures due to applying reverse polarity power. These were corrected and the unit was reinstalled in ALVIN. Again there were compass failures due to power transients and over voltage being applied to the compass. The compass was sent to the factory for overhaul and then taken to Andros Island for installation in ALVIN where proper operation was not obtained. After factory rebuilding of the compass, it was taken to Nassau, Bahamas and installed in ALVIN by Gyrosystems Inc. personnel.

The compass operated for several days but failed during transit from Nassau to Woods Hole. The compass was returned to Gyrosystems Inc. and was again completely rebuilt and delivered to Woods Hole in time for the FAMOUS operation.

The Model 800 gyrocompass was installed in ALVIN at the start of the summer and operated in ALVIN until 9 August 1974. Checks of Model 800 heading and ship's heading indicated good correlation. Good heading data was obtained both on the surface and during ALVIN dives. On August 9th, when ALVIN/R/V LULU were in port at Ponta Delgada, Azores, the power was turned off in ALVIN for an overnight period. When power was restored the compass would not north seek but drifted at about a 1° per minute rate. Subsequent evaluation at the factory has indicated an electronic failure probably due to power switching transients.

Figure 6 shows the brush recorder chart for the gyro during a dive on the Mid-Atlantic Ridge. This record shows a smooth trace that can be assumed to be accurate within a few degrees and follows the changes in heading of ALVIN very well.

Table 3 gives the comparison data on the Gyrosystems gyrocompass. The date, dive number, ship's compass reading as reference, and the Gyrosystems Model 800 readings are shown. All readings were taken with ALVIN on the deck of LULU. Since there could be some offset due to mounting or alignment, an "offset" is calculated to be the average of the corrections, where correction is ship reference heading minus Model 800 heading. This offset is subtracted from each correction to obtain a "net correction". The average magnitude of the net correction is called average

error. The offset was 3.6° , average error was 4.6° and the peak to peak maximum error was 21° .

The Gyrosystems Inc. Model 800 gyrocompass performed well with acceptable accuracy from 5 June 1974 to 9 August 1974. The compass has exhibited a sensitivity to power interruptions while being used in the ALVIN Group at the Woods Hole Oceanographic Institution. As a result of this the compass has not given good reliability in an operational environment.

Gyrosystem Gyro Data

Table 3

Date	Dive	Ship	Alvin	Corr	Net
1974					
6/29		305	315	-10	-6.4
6/30	518	272	268	+4	7.6
7/1	519	296	294	+2	5.6
7/2	520	088	095	-8	-4.4
7/3	521	095	095	0	+3.6
7/4	522	278	280	-2	1.6
7/5	523	031	031	0	3.6
7/14		115	130	-15	-11.4
7/15	524	152	160	-8	-4.4
7/16	525	152	156	-4	-.4
7/17	526	207	212	-5	-1.4
7/18	527	074	080	-6	-2.4
7/19	528	276	270	+6	9.6
7/20	529	047	061	-14	-10.4
7/21	530	235	240	-5	-1.4
8/3	532	140	136	+4	7.6
8/4	533	129	128	+1	4.6
8/5	534	190	194	-4	-.4
8/6	535	273	277	-4	-.4
			Offset	-3.6	Avg - 4.6°

Figure 1.

BRUSH RECORDER TRACE OF
GYRO HEADING WITH ALVIN
ON DECK OF LULU
SPERRY SUBMINATURE
GYROCOMPASS

Figure 2.

BRUSH RECORDER TRACE OF
GYRO HEADING WITH ALVIN
DIVING ON A SEA MOUNT
SPERRY SUBMINATURE
GYROCOMPASS

Figure 3.

Figure 4.

Figure 5.

BRUSH RECORDER TRACE OF
GYRO HEADING WITH ALVIN
DIVING ON MID-ATLANTIC RIDGE
GYROSYSTEMS MODEL 800

Figure 6.

Figure 7.

Appendix I

The following schedules records the transit, dive and in port periods for the evaluation period.

5 June 1974 Underway from Woods Hole, Ma. ALVIN on the R/V KNORR. Gyrosystems 800 installed in ALVIN and operating. Sperry subminiature gyrocompass installed and operating in the wet lab of R/V KNORR. R/V KNORR uses a Sperry MK 37 Gyrocompass.

21 June 1974 Arrived in Ponta Delgada, Azores. ALVIN transferred to R/V LULU and Sperry subminiature gyrocompass installed on R/V LULU. R/V LULU uses a Sperry MK 14 Gyrocompass.

21 June 1974 Departed for Test Dive
& 22

23 June 1974 Test Dive

24 June 1974 Departed for Leg 1 of Project FAMOUS

7 July 1974 Arrived Ponta Delgada

11 July 1974 Departed for Leg 2

26 July 1974 Arrived Ponta Delgada

27 July to Test Dive

28 July 1974

31 July 1974 Departed Ponta Delgada for Leg 3 of Project
FAMOUS.

9 Aug. 1974 Arrived Ponta Delgada. Gyrosystems 800 failed
in Port. Power was removed from Gyro for in-
port period.

13 Aug. 1974 When power restored, the compass had continuous
drift. Sperry compass installed in ALVIN. De-
parted Ponta Delgada, Azores for New England
Sea Mount Dives.

3 Sept. 1974 Arrived in Woods Hole, Ma.

16 Sept. 1974 Departed for Hudson Canyon.

23 Sept. 1974 Arrived in Woods Hole, Ma.

2 Oct. 1974 Departed for Bottom Station #1

7 Oct. 1974 Arrived in Woods Hole, Ma. The Sperry Gyro-
compass was removed for return to Sperry for
factory evaluation. The unit operated very
satisfactorily during the total operation.