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Campagne FARE

Wireline Reentry of DSDP Hole 396B Using the NADIA System

PAGES 729-730, 741

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In July 1988, IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer) carried out the first wireline reentry of a borehole on the deep seafloor using the NADIA (Navette de Diagraphie) system at DSDP Site 396B near the Mid-Atlantic Ridge and the Kane Fracture Zone. Water depth was 4455 m. The project was called Campagne FARE (faisabilité Re-Entrée). The NADIA system is a cone-shaped aluminum frame emplaced on the reentry cone by the deep-sea submersible *Nautile. Nautile* also provides the hydraulic power and electric control signals to run the winch on NADIA that lowers logging tools into the borehole. Five logging runs were made: a water sampler (outside diameter of 100 mm) was lowered to 170 m into the hole, which was cased to 170 m; a temperature probe (outside diameter of 200 mm) was lowered to 204 m; the water sampler was run again to a depth of 301 m (130 m into open hole in basalt); a dummy probe (outside diameter of 150 mm) was lowered to 301 m; and the temperature probe was run a second time to 301 m. The total hole depth was originally 405 m, and it appears that the hole has filled in about 100 m (all depths are quoted to ±5 m). The measurements indicate that bottom water is still flowing into the hole 12 years after drilling. Wireline reentry is an exciting new technological development that will enable use of deep-sea boreholes for geoscience experiments after the drill ship leaves.

Introduction

This paper describes the successful field test of the NADIA (Navette de Diagraphie, which means logging shuttle) wireline reentry system, an apparatus designed and built by IFREMER (Institut Française de Recherche pour l'Exploitation de la Mer) to place instruments and to carry out well logging in boreholes in the deep sea without a drill ship. The Campagne FARE (Faisabilité Re-Entrée) field tests in July 1988 in DSDP (Deep Sea Drilling Project) Hole 396B (near the Kane Fracture Zone at the Mid-Atlantic Ridge (Figure 1)) demonstrated the feasibility of routine reentry and logging in a water depth of 4455 m.

The NADIA system [*Legrand et al.*, 1988] is emplaced on the reentry cone by the deep-sea submersible *Nautile. Nautile* also provides the hydraulic power and electrical control signals to run the winch on NADIA that lowers and raises logging tools in the borehole. A custom-made deep-sea hydraulic and electrical connector enables *Nautile* to connect and disconnect from NADIA at depth.

One previous attempt at wireline reentry was made from the D/V *Glomar Challenger* on DSDP Leg 88 [*Stephen et al.*, 1987]. A reentry sled with scanning sonar and a transponder was lowered 3000 m below the drill ship and its response to ship motion was monitored. However, the sled did not carry a logging tool and the hole on the seafloor was not located.

Boreholes on the deep ocean floor are not merely relics of a sample acquisition proce-

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Cover. NADIA is a deep-sea device for reentering DSDP boreholes with logging tools. It is a project of IFREMER (Institut Français de Recherche Pour l'Exploitation de la Mer) and is deployed with their deep-sea submersible, *Nautile*. The photo shows NADIA in the reentry cone of DSDP Hole 396B during engineering tests in July-August 1988. This was the first time that reentry of deep-sea boreholes has been carried out without the drill ship.

See "Campagne FARE: Wireline Reentry of DSDP Hole 396B Using the NADIA System," by Jacque Legrand et al., page 729.

TABLE 1. Experiments That Can Utilize Wireline Reentry Capability

Magnetotellurics
Nested Packer Array
Resettable Straddle Packer
Long-Term Monitoring and Sampling of Pore Fluids
Borehole Gravity
Side Wall Sampling
Physical Properties Measurements
Magnetic Logging
Offset Vertical Seismic Profiles
Zero Offset Vertical Seismic Profiles
Cross-Hole Seismic Experiments
Borehole Televiewer
Permanent Triaxial Seismic Station
Precision Long-Term Pressure Measurements
Short-Period Pressure Measurements
Crustal Deformation Observatory
Vertical Seismic Array
High-Frequency Seafloor Seismic Array

From *Langseth and Spiess* [1987].

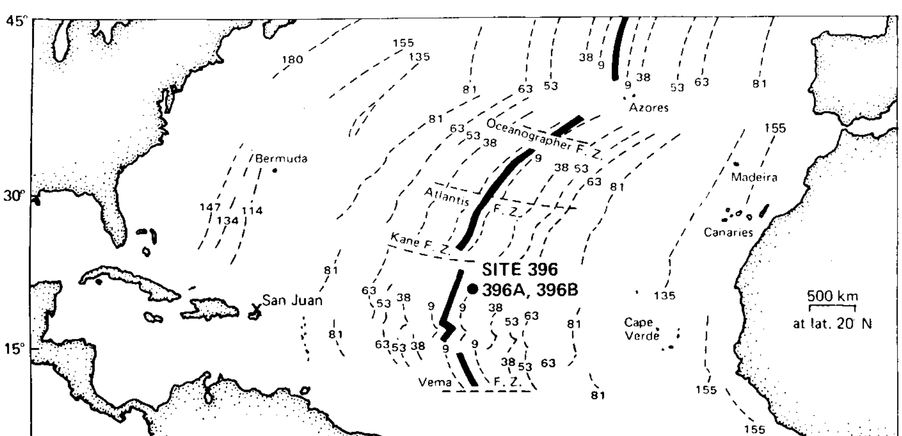

Fig. 1. Location of DSDP Site 396.

dure. They are an asset that can be exploited to carry out a broad range of scientific experiments to study geological, geophysical, and geochemical processes in the seafloor. The development of wireline reentry technology is a significant step in reaching the goal of routinely instrumenting boreholes in the deep sea.

Scientific Objectives of Wireline Reentry

In February 1987 a meeting was held at Scripps Institution of Oceanography, La Jolla, Calif., to summarize the scientific benefits that would arise from a wireline reentry capability [*Langseth and Spiess,* 1987]. A list of the borehole experiments included in their report is given in Table 1. Remedial logging could be carried out in holes that were never logged, had poor quality logs, or had key logs missing. New logging techniques, developed since the hole was drilled, could be run without bringing back the drill ship. Short-term experiments requiring a few days and a second ship (such as Oblique Seismic Experiments) could be carried out with wireline reentry from a single ship on a schedule independent of the drill ship. Long-term installations, such as borehole seismic stations for earthquake studies could be emplaced and maintained using the wireline reentry technology. Tools, currently too large to emplace through the drill string from the drill ship could be deployed. Boreholes could provide the focus for long-term seafloor observatories in which a broad range of geoscience parameters could be measured. Although many of these objectives can be carried out with a drill ship, the wireline reentry capability will let the drill ship concentrate on drilling holes and thus increase the cost effectiveness of that expensive resource. Let drill ships do what they do best—drill.

Langseth and Spiess [1987] identified 29 sites drilled before 1987 that had reentry cones. An updated list is given in Table 2. Thirty-six holes are either deeper than 300 m into sediment or were drilled to basement. Of course, the currently active Ocean Drilling Program continues to drill new holes. With the advent of wireline reentry technology, holes can be drilled with special attention paid to optimizing their future use, for example, setting casing at least to basement, fishing out broken or lost apparatus, leaving the hole filled with mud to improve hole stability.

TABLE 2. Reentry Holes as of August 1988

Hole	Leg	Water Depth, m	Hole Depth, m	Sediment Thickness, m	Length of Casing, m	Location	Latitude	Longitude	Comments	Reentry Status*
110	12	3053	39	bnr	25	Off New Jersey	37°59.39′N	71°46.65′W	Top of cone at 3026 m	P
146	15	3957	762	738	50	Caribbean	15°06.99′N	69°22.67′W	Old style cone	G
288A	30	3030	989	bnr	56	Ontong Java Plateau	5°58.35′S	161°49.53′E	Bridged at 105 m	G
319A	34	4296	157	98	66	East Pacific Rise	13°01.04′S	101°31.46′W	Bad hole in basement	G
320B	34	4487	183	130	65	Peru Basin	9°00.40′S	83°31.80′W	Bad hole in basement	G
332B	37	1841	721	139	68	MAR Famous area	36°52.76′N	33°38.57′W	Casing parted from cone	P
333A	37	1666	529	219	61	MAR Famous area	36°50.45′N	33°40.05′W		G
395A	45	4485	664	88	111	MAR-Kane	22°45.35′N	46°04.90′W	Casing cemented	E
									Junk in hole	
396B	46	4465	406	152	163	MAR-Kane	22°59.14′N	43°30.90′W	Reentered with NADIA	E
398D	47	3900	1740	bnr	80	Galacia Bank	40°57.6 ′N	10°43.10′W	Hole plugged	P
400A	48	4399	778	bnr	75	Bay of Biscay	47°22.90′N	9°11.90′W	Whole drill string in hole	P
415A	50	2817	1079	bnr	331	Off Morocco	31°01.65′N	11°39.97′W	Casing cemented	G
									Cone ring flush	
416A	50	4203	1605	bnr	40	Off Morocco	32°50.18′N	10°43.10′W	Bad hole conditions	G
417C	51	5489	26	bnr	26	Bermuda Rise	25°06.56′N	68°02.63′W	Broke off before release	P
417D	51/52	5489	709	343	25	Bermuda Rise	25°06.69′N	68°02.81′W	BHA in hole	G
418A	52/53	5519	868	324	71	Bermuda Rise	25°02.08′N	68°03.45′W	Needs surface casing	G
433C	55	1874	551	163	40	Suiko Seamount	44°46.63′N	170°02.23′W	Needs surface casing	G
438B	57	1575	1039	bnr	41	Japan fore arc	40°37.80′N	143°14.80′E	Pipe in hole	G
442B	58	4645	455	290	66	Shikoku Basin	28°59.04′N	136°03.43′E	Bad hole conditions	P
									Needs surface casing	
462A	61	5186	1208	563	75		7°14.50′N	165°01.90′E		G
482D	65	3012	187	138	59	Gulf of California	22°47.31′N	107°59.21′W	HIG seismometer	P
483B	65	3084	267	107	66	Gulf of California	22°52.99′N	108°14.84′W	Cased to basement	P
									Cone blocked by bit	
504A	69	3468	278	264	90	Costa Rica Rift	1°13.6 ′N	83°43.95′W	Small trash in hole	G
504B	69, 70	3474	1562	274	276	Costa Rica Rift	1°13.61′N	83°43.81′W	Cased to basement	G
	83, 92,								Junk at T.D.	
	111								Bad hole conditions	
534A	76	4976	1647	1619	533	Blake-Bahama Basin	28°20.63′N	75°22.89′W	Liner required for deepening	E
547B	79	3952	1030	bnr	28	Moroccan margin	33°46.84′N	9°20.98′W	Needs surface casing	G
553A	81	2339	683	499	60	Rockwall Plateau	56°05.32′N	23°20.61′W	Bit in hole	E
581B	86	5478	367	353	364	NW Pacific	43°55.66′N	159°47.77′W	Severed above seafloor	P
595B	91	5630	124	68	74	Southwest Pacific	23°49.30′S	165°31.60′W	MSS stinger in cone	G/E
597C	92	4157	110	47	40	Southeast Pacific	18°48.39′S	129°46.23′W		G
603B	93	4644	1585	bnr	500	U.S. Continental Rise	35°27.70′N	70°01.90′W	Whole drill string lost	P
638C	103	4673	547	bnr	44	Galicia Margin	42°09.19′N	12°11.82′W	Bad hole conditions	P
642E	104	1289	1229	312	372	Voring Plateau	67°13.2 ′N	2°55.8′ W	Top of cone is at the seafloor	G
645E	105	2018	1147	bnr	19	Baffin Bay	70°27.43′N	64°39.26′W	Condition is questionable	P
648B	106	3341	83	none	28	MAR	22°55.32′N	44°56.82′W	Hard rock guide base	P
									Bad hole conditions	
735B	118	732	500	none	none	Atlantis II Fracture Zone	32°43.34′S	57°16.3′ E	Hard rock guide base	G
763B	122	1379	656	bnr	50	Exmouth Plateau	20°35.14′S	112°12.49′E	XCB in hole	P
765D	122	5724	1195	928	933	Argo Abyssal Plain	15°58.54′S	117°34.50′E		G

bnr, basement not reached; N/R, not reported in initial report chapter; MAR, Mid-Atlantic Ridge.
*G, good; P, poor; E, excellent.

The most interesting holes for ocean crustal studies such as 504B, 417D, 418A, 395A, and 396B are all candidates for more detailed studies using wireline reentry. Also, many of the objectives of future drilling on the East Pacific Rise will require repeated use of holes. Due to the small hole size (about 4 inches, or 102 mm) of the bare rock drilling capability currently under development, wireline reentry will be essential to get conventional size logging tools into holes.

In April 1988 a meeting on Downhole Seismometers in the Deep Ocean was convened at Woods Hole Oceanographic Institution, Woods Hole, Mass. [*Purdy and Dziewonski*, 1988]. The issue of extending the World Wide Standard Seismograph Net to include seafloor seismometers in boreholes was discussed. The period range of interest varies from 0.1 to 1000 s. At the meeting, wireline reentry was identified as one of the important technological developments that would make such stations possible.

NADIA System

NADIA is a nonpropelled, free-falling device [*Legrand et al.*, 1988]. Descent to the seafloor and return to the surface are achieved by gravity and buoyancy. The horizontal displacement between the landing point and the cone location is achieved by the submersible.

NADIA is composed of four subsystems (see Figure 2), which are described below.

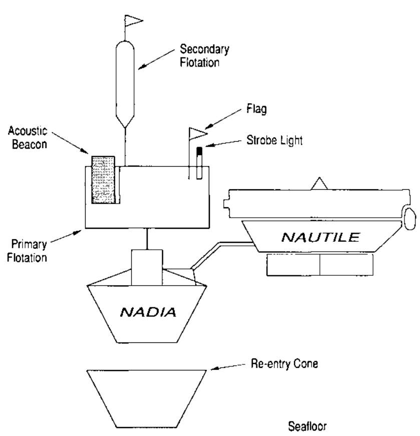

Fig. 2. General configuration of the NADIA deployment system.

- A mainframe, built of welded aluminum alloy tubes, fitted with a winch and its hydraulic control system, the logging tool, the electrohydraulic connector, a 10-m umbilical link to the submersible, and ancilliary equipment (mechanical releases, dead weights, cable cutter, etc.).
- A main flotation assembly supporting the weight of the mainframe. It is fitted with an acoustic navigation beacon for tracking NADIA during the vertical trips and rendezvous with the submersible.
- A secondary flotation assembly released to ballast the mainframe and to dock it down in the reentry cone.
- A descent dead weight, released by the submersible before moving NADIA to the reentry cone.

A logging operation with NADIA proceeds in the following steps (Figure 3).

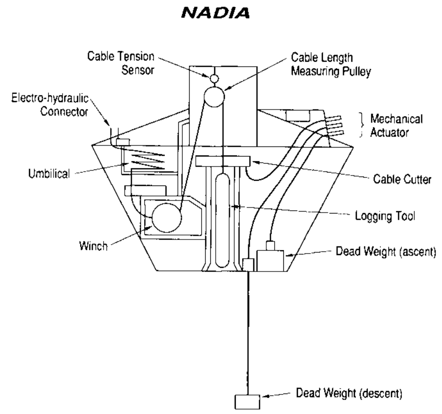

Fig. 3. Detail of the NADIA frame showing winch, tension and depth indicators, logging tool, and release weights.

1. Launching of the frame and the flotation assembly when the ship is in a position that gives the closest impact of the system from the cone.
2. Landing at the sea bottom. Length between descent weight and frame is chosen to prevent NADIA from overshooting or hitting the seafloor.
3. The submersible dives. Rendezvous with NADIA with the help of the acoustic navigation system and a flashlight. The submersible holds NADIA with one arm, adjusts her ballast to become neutrally buoyant with NADIA and releases the descent weight. The submersible moves NADIA toward the cone using its propulsion system.
4. Hovering of NADIA above the cone—the secondary flotation assembly is released and NADIA is set in the cone.
5. The submersible connects with the electrohydraulic connector to NADIA.
6. Lowering the logging tool. Winch control and data acquisition are in the submersible sphere. If the tool is blocked, the wire tension decreases and the operator stops the winch.
7. Raising the logging tool back in NADIA's frame. This operation is similar to phase 6. If the tool gets blockd in the hole, and if it cannot be worked free by operating the winch back and forth, two levels of security are available.
   - A shear pin rated at 6000 N provides a weak point at the cable head. A fishing neck at the tool's upper end will permit the use of the fishing overshot in use on board the D/V *Joides Resolution.*
   - A hydrostatic cable cutter is fitted in NADIA's frame. In case the shear pin cannot be used, the cable can be cut to set the system free from the cone.
8. At the end of the operations the logging tool is raised back in the frame. The submersible disconnects the electrohydraulic link and replaces it in the basket.
9. The submersible holds NADIA, lifts it up out of the cone and moves a few meters off. The ascent weight is released. NADIA is set free and pops up to the surface.
10. The system is recovered on board the ship.

Reentry Tests

Upon reentry at the site, a long-baseline transponder network was installed and referenced to Global Positioning System (GPS) satellite navigation (Figure 4). The acoustic network was used to navigate the submersible, *Nautile,* and the mother ship, *Nadir.* We knew the cone location within 200 m from satellite fixes taken during drilling in 1976. The cone was located on the first dive within one hour of landing on the seafloor.

A photograph of the reentry cone is shown in Figure 5. Normally, the bottom of the cone is intended to be on the seafloor, but at Site 396 the cone sank into the mud until the top of the cone was 1 m below the seafloor (bsf). We had hoped that the cone would be a sonar target. However, an old DSDP transponder was still at the site and this was a target that aided the finding of the cone. Figure 6 shows NADIA emplaced in the reentry cone.

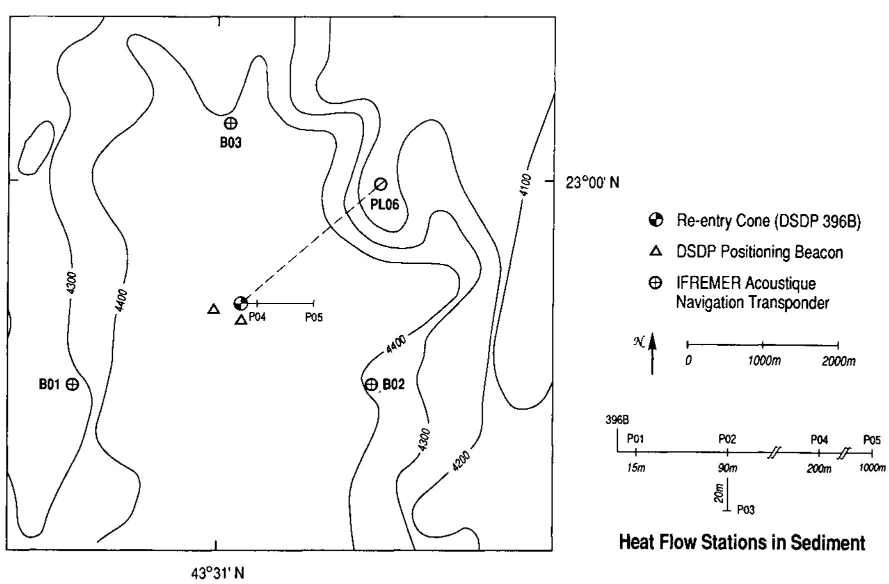

Fig. 4. Map of transponders reentry cone, and bathymetry for Campagne FARE at Site 396.

A summary of the 11 dives made on the cruise is given in Table 3. Initially, two dives were used for each reentry attempt. The logging device is installed on NADIA on the surface. The first dive deploys and emplaces NADIA, and the second dive carries out the logging run and recovers NADIA. We carried out four reentries in this fashion, and a fifth reentry was carried out by deploying and recovering in one dive.

NADIA was emplaced on the second dive with a water-sampling device built by Scripps Institution of Oceanography. The next two dives were used in systems testing and succeeded in lowering the sampler (outside diameter of 100 mm) to 170 m bsf. The hole had been cased with 11-inch (298 mm) casing to 170 m through 150 m of sediment and 20 m of basalt. The drill bit diameter was 9⅞ inch (251 mm).

The second reentry on dives five and six ran a temperature probe (outside diameter 200 m) to 204 m. The third reentry on dives seven and eight ran the water sampler again to 301 m, and the ninth dive ran a dummy probe (outside diameter of 150 mm) to the same depth. The final two dives ran the temperature probe a second time to 301 m. In 11 dives, five logging runs were carried out. Table 4 summarizes the significant depths at Hole 396B. The engineering tests of the NADIA system were an unqualified success.

Scientific Background of Site 396 and Preliminary Results

DSDP Sites 395 and 396 (Legs 45 and 46) were part of a designated program of deep penetrations into layer 2 of oceanic crust along an Atlantic transect. Hole 396B occupied the most time on Leg 46 and penetrated to a depth of 256 m into basaltic layer 2, in addition to 150 m of sediment [*Dmitriev et al.*, 1978*a*, *b*]. This was also the first hole in which a serious logging attempt in layer 2 was made [*Kirkpatrick*, 1978].

The importance of logging lies in the fact that it yields information on the physical and structural information on that part of the basalt column of layer 2 that is not recovered in the drilling process. Such losses are often very large, particularly in zones that show alteration and brecciation. Hole 396B is a typical example of this, with core recoveries in the upper 150 m of layer 2 being very low as a result of brecciation. Previous logging consisted of logs below the point of cementation of the well casing (about 165 m bsf) to a total depth of about 380 m bsf, i.e., 230 m into layer 2. A standard set of Schlumberger logs for gamma ray, density, neutron porosity, resistivity, and sonic velocity was run. The gamma ray, porosity, and resistivity logs were of great importance in that they confirmed the thickness and relative permeability of the brecciated sections of the hole.

In addition to the logging program, a detailed program of temperature measurements in the sediment column (three measurements) and into the basalt was carried out [*Erickson and Hyndman*, 1978]. The former led to an estimate of the heat flow in the sediment column of 0.54 μcal cm^{-2} s^{-1} (about 17°C km^{-1}), which was of the same order of magnitude as the site survey heat flow data (0.27 and less than 0.7 μcal cm^{-2} s^{-1} [*Purdy et al.*, 1978]. From the small change of 0.1°C from bottom water temperatures of 2.52°C, *Erickson and Hyndman* [1978] concluded that at least to a depth of 20 m into layer 2, i.e., about 170 m bsf, downward movement of water must occur. This implies the motion of bottom water into layer 2, a phenomenon also observed in Site 395 [*Becker et al.*, 1984; *Langseth et al.*, 1984] and Site 504B [*Becker et al.*, 1983, 1985]. *Kirkpatrick et al.* [1978] concluded that the principle reason for this inflowing water may be the breccia zones deeper down in the hole, though temperature logging was stopped only 20 m into layer 2.

During Campagne FARE, two temperature logs were run, one to 204 bsf and one to 301 m bsf. The results are shown in Figure 7. These results indicate that continued flow of bottom water occurs in this hole but that the flow into the bottom part of the hole is severely hampered by the presence of a fill consisting of a mixture of sands and bentonite to 300 m bsf. Nonetheless, the continued flow into the hole supports the essential continuity of open pore spaces and cracks over large lateral distances in layer 2. Under normal circumstances, this flow is fed from the exposed rocks at the edge of the sediment-filled depression. This model was invoked by *Erickson and Hyndman* [1978] to explain the low heat flow in this area. In addition, a water-sampling program was carried out designed to study the composition of the seawater filling the hole. Such studies may indicate the presence of down-welled bottom water and/or changes in the chemical composition as a result of exchange and reaction with the basalts [*Gieskes et al.*, 1984; *McDuff*, 1984; *Mottl et al.*, 1983, 1985; *Leg 102 Shipboard Scientific Party*, 1986]. Preliminary results indicate the presence of bottom water to at least 260 m bsf.

Conclusions

Campagne FARE has clearly demonstrated the feasibility of reentering DSDP Hole 396B in a water depth of 4455 m. The hole was cased 170 m to basement and was open a further 133 m into open hole in the basalt. The logging measurements indicate that water is still flowing downhole 12 years after drilling.

TABLE 3. Campagne FARE Dive Summary

Number	Date	Passenger	Task
1	July 25	Harmegnies	Search for cone do heat flow released two old DSDP transponders
2	July 26	Echardour	emplace NADIA
3	July 27	Legrand	reentry test to 1 m water sampler
4	July 28	Legrand	170-m reentry release NADIA
5	July 29	Floury	emplace NADIA 204-m reentry temperature probe
6	July 30	Alliet	release NADIA photography and reconnassiance survey of sediment pond
7	July 31	Floc'h	emplace NADIA 300-m reentry water sampler
8	August 1	Pozzi	release NADIA do heat flow
9	August 2	Loaec	emplace NADIA 301-m reentry dummy probe release NADIA
10	August 3	Raer	emplace NADIA 310-m reentry temperature probe
11	August 4	Stephen	release NADIA survey Hole 396

TABLE 4. Depth Summary in Hole 396B

	Below Lea Level, m	Below Seafloor, m	Into Basement, m
Mud-line	4455		
16″ casing	4582	127	
Sediment-Basement Contact	4606	151	
11 3/4″ Casing	4625	170	19
Water Sampler Probe 1	4625	170	19
Temperature Probe 1	4659	204	53
Water Sampler Probe 2	4756	301	150
Temperature Probe 2	4756	301	150
Dummy Probe	4756	301	150
Top of Fill	4756	301	150
Bottom of Hole	4860	405	254

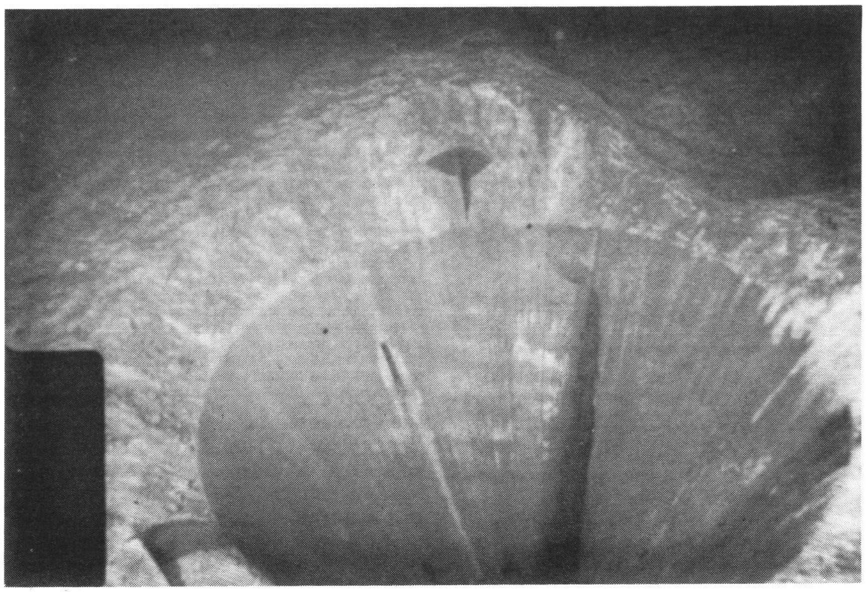

Fig. 5. Photograph of reentry cone at DSDP Site 396.

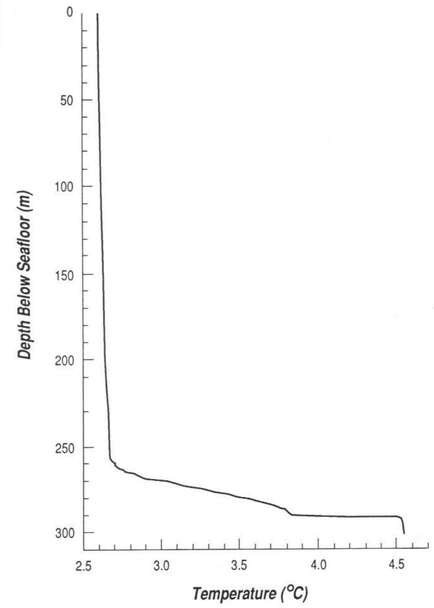

Fig. 7. Preliminary temperature-depth profile obtained with the NADIA system.

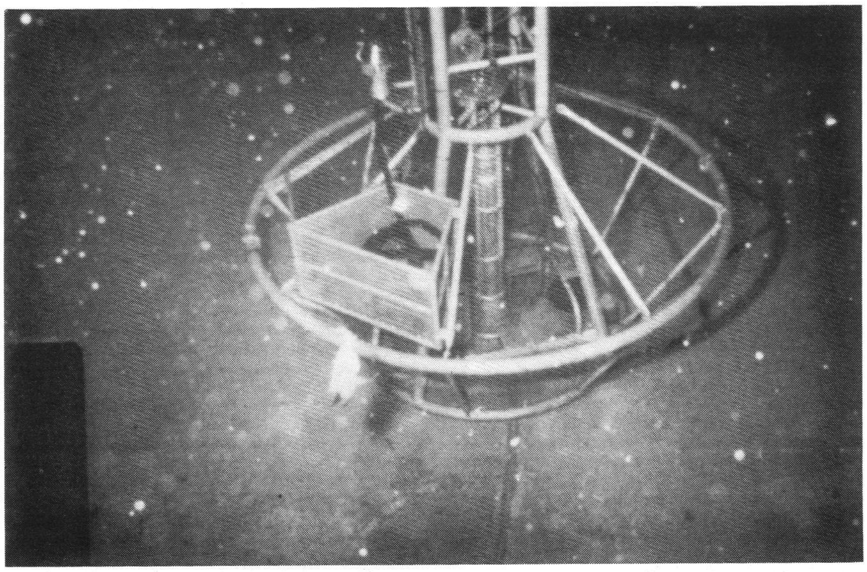

Fig. 6. Photograph of NADIA on the seafloor at Site 396.

The acronym for the project, FARE, originally short form for Faisabilité Re-Entrée (feasibility of reentry), can now be changed to Fait Re-Entrée (fact of reentry).

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Editorial

250 Manuscripts Before the Mast

PAGES 729, 731

Reflections of an Outbound Editor

Two and a half years of service as an editor of the *Journal of Geophysical Research-Solid Earth and Planets* have given me some experiences and insights about writing and reviewing research reports, which I offer here as an editorial swan song. Let me start with a few of the highlights of my tenure.

- The author at a Pacific atoll observatory who wrote that the arrival of his long-awaited acceptance letter cured him of malaria.
- The referee who copyrighted his review so that the authors could not incorporate his corrections without violating the copyright.
- The reviewer who blamed the authors for someone else's unsuccessful tenure application, which led to a furious and even more fatuous reply to the offending reviewer by one of the authors, suggesting that the reviewer's science was no more informative than stirring the entrails of dead sheep (although "Dead Sheep Entrails" did sound like a good topic for a Special Issue). From this exchange and the foregoing I learned that some reviews are best returned to sender.
- The many reviewers who took umbrage that my admonishment to reviewers (the offspring of "Sheep"), "to be polite in all remarks to be seen by the author," was a preemptive strike on their history of sending lurid reviews to the editors.
- The guest Associate Editor of a Special Issue who pressed his authors to meet the submission deadline, only to fail to get either his own paper or his introduction to the Special Issue written.
- The author whose paper was destroyed beyond reconstitution by a typhoon.
- The author who asked me if I thought he should submit a paper to a Special Issue and, when I encouraged him to do so, wrote the guest AE that his paper had already been accepted and he would just be putting the finishing touches on it.
- The authors of a 116-page treatise who, when I wrote that I wanted their manuscript split into two papers (the first of which was accepted and the second provisionally so), called me in a rage that I had "dealt them a deathblow."
- The second author who refused to make any requested revisions to the manuscript of the then-absent first author (his graduate student) because that would put the student's work in a more favorable light than it deserved.
- The third-world author from whom I received a steady stream of greeting cards but no revised manuscript.
- The Associate Editor whose reviews carried this disclaimer in microscopic print:

> I am not responsible for the contents of this letter but am being forced to write it by terrorist graduate students.

- Getting manuscripts from everyone—regardless of discipline—who figured I owed them a favor or to whom I was related by marriage.

I also would like to commend for valor:

- The many unselfish scientists who performed saintly acts for third-world and Eastern European authors by translating and typesetting the text into standard English, redrafting figures, and helping the authors respond to reviews.
- The AGU Publications staff, who put up with my ever-mounting requests for more computer hardware, software, printers, copiers, furniture, file cabinets, phone lines, and assistant's hours, and who were forbearing in the face of my constant whine for fewer manuscripts, weekly page-charge-experiment reports, monthly expense and manuscript reports, and semiannual editor's reports.

Standing in judgment on papers sent to me during the same period when I was submitting manuscripts to other imperious editors taught me something about my own frailties as an author and reviewer. Here is my perception of some of the key problems encountered in writing and reviewing scientific papers.

Writing

The editorial message of *JGR* is simple: Give us your best work. That does not, by necessity, mean your longest treatise or your experiment with the latest technology, but your most important research report and, because of this, a finely crafted manuscript. Perhaps the principal reason why submitted papers are not the best they can be is that many are sent into the world about two months premature. What happens to these "preemies" is that the editor and referees are forced to decode the text, reorganize and streamline the prose, and search for the key contribution of the investigation. More often than not, the premature delivery also means matching sketchy Figure 9 to its caption as Figure 10 and its callout as Figure 11. Under such circumstances, reviewers tend to glaze over and put the paper under a pile somewhere. Everyone goes comatose.

I have found that authors who can summon the patience to ask their colleagues—both someone within the field and someone well outside it—to read their paper before it is submitted fare immeasureably better in the review process. Before a paper is written, ask yourself, to whom is this paper addressed? Write for the widest possible audience, so that your efforts are rewarded by readers. Instead, most of us write papers with just a few enemy referees in mind. That leads to a bunker mentality. The manuscripts are written defensively, encrypted with jargon, and with protected ramparts rather than exposed logic and flaws. Papers the rest of us can understand, and in which shortcomings are acknowledged along with successes, will gain credibility and their authors maintain integrity.

As our last act before submission, most of us place the Conclusions in a trash compactor and turn the key. Voilà! Out comes the abstract. The result is text in its densest packing configuration. Of all the sections in the manuscript, it is the abstract that will be most widely read and thus must be most easily read. The abstract not only telegraphs the key message of the paper, it should also invite people to read further. Use the abstract to tell us why the work was done, what's new, and why it's important—with "Details at 11." Too much compression or too many facts rob an abstract of clarity and impact.

Reviewing

The fundamental purpose of reviewing is to identify ways to make submitted papers better; screening out ill-conceived manuscripts is subservient to this goal. Most referees approach a manuscript like a school marm grading a math test. The paper arrives with a score of 100 and is marked down for every mistake uncovered; the surviving paper has the least red ink in the margins.