

MEMORANDUM

To: Minerals Management Service

From: U. S. Geological Survey, Fisher Island Station

Subject: Cruise Report, Wellhead Search and Discovery, Offshore
Key West, Florida

CAPTAINS' LADY
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INTRODUCTION

The purpose of this report is to describe the search efforts and successful location of four underwater sites where exploratory oil wells were drilled in the vicinity of Key West, Florida, in the late 1950s and early 1960s. This work was part of Phase One of a two-part MMS-funded study consisting of (1) location and verification of sites (Phase One) followed by (2) biological and geological assessment of the impact caused by drilling (Phase Two).

Seven offshore wells were drilled off south Florida in the late 1950s and early 1960s. Of the seven wells, three were drilled in coral reef areas to the west of the Marquesas Keys, three were drilled in less than 20 ft of water on hard bottom adjacent to the Marquesas Keys approximately 20 miles west of Key West, and one was drilled in Florida Bay approximately 7 miles south of Cape Sable. These locations (all but the Florida Bay well are shown in Fig. 1) represent three of the most environmentally sensitive environments in south Florida. The Florida Bay site is in an area of extensive marine grasses adjacent to the largest stand of mangroves in the United States. The Marquesas Keys/Boca Grande Channel sites represent productive hard bottom populated by marine grasses, algae, and abundant soft corals. The area is extensively fished for spiny lobster. The

adjacent Marquesas Keys, a Halimeda (calcareous alga) accumulation, is populated by grasses, a restricted West Indies shrub flora, Ficus trees, coconut and Thrinax palms, and red, black, and white mangroves. The Marquesas Keys area is a Fish and Wildlife Service bird sanctuary. The well sites to the west and south of the Marquesas, on the other hand, are near the shelf break on a "live bottom" populated by both hard and soft corals and abundant alcyonarians. The area is extensively fished by commercial lobster fishermen. Tidal currents are often strong, and the Florida Current or Gulf Stream meanders over the area. During the summer, the water is clear and the bottom is visible from the surface. During winter months, however, cold, turbid water from the Gulf of Mexico often covers the entire area.

METHODS

To find the drill sites, we used a simple wreckfinder's proton magnetometer. The device is portable and powered by an ordinary automobile battery (12 volts). The magnetometer interfaces with a small printer which, in turn, interfaces with a Loran C unit. The printer prints the magnitude of magnetic anomaly in the vicinity of the towed detector, as well as the Loran C TDs of the boat's location every 4 seconds. The sensor "fish" was towed at a depth of 15 ft 100 ft behind the chartered 50-ft vessel "Captain's Lady."

By converting the latitude and longitude coordinates provided by MMS and the State of Florida Geological Survey to Loran C TDs (which provides greater accuracy), we were able to cruise to the well site area where a large flagged buoy was then

deployed. This buoy served as the center for a magnetometer search grid. Lines were run in an east-west direction where possible, because detection of magnetic anomalies is more sensitive in this direction. Line spacing, for the most part, was between 100 and 200 ft. Small buoys were deployed from the moving vessel when significant anomalies were encountered. The fish was towed at a speed of approximately 4 knots. Sites were verified by diver observation before searching for other wellheads.

Before beginning the search, we ground-truthed the magnetometer at well sites D and E1, found by diving several years ago (see Table 1 and Fig. 1). This phase of the search proved most important because it demonstrated the magnitude of anomaly to be expected. The exercise also demonstrated that the wellheads can be detected from at least 200 ft away because the wellheads produced anomalies of 30 gammas or more. See Figure 2 for examples of wellhead anomalies.

Detailed day-to-day cruise activities are included in the Appendix and show that of the 22 cruise days (out of a 30-day charter), the boat was at sea only 11 days due to a tropical wave and winter cold fronts which begin to arrive at this time of year. Because of deteriorating weather, it was decided to postpone the search for the remaining two wells (sites B and C) until spring, when weather conditions are calm and the water clear. Success in finding site A under less than ideal conditions indicates that the two remaining sites should be easy to find given calm conditions. In addition, these sites are far from port, and calm conditions would allow the vessel to remain

on station at anchor during the night.

RESULTS

Table 1 lists all the sites provided by MMS, additional sites, and the well sites found during this search. Also listed are the Loran C TDs obtained after verification by diving.

Sites D and E1. This site, in 15 ft of water, was previously examined and used to ground-truth the magnetometer. The site actually consists of two wells, one of which was abandoned because of hole problems. The two wells are approximately 200 ft apart, not 790 ft apart as indicated in drilling reports. Although the water was extremely turbid due to weather (<3 ft visibility), diver verification was nevertheless possible. The site of well D is characterized by more than 100 cement bags (cement that hardened in the bags), various lengths of cable, pipe, angle iron, and other metallic debris. The wellhead is hidden beneath the pile of cement bags. The adjacent well, E1, is beneath a cement slab. The bottom is also littered with limestone pebbles. The pebbles were brought to the site by the drilling contractor to stabilize the rig. A tricone drill bit was resting on top of the cement bags when we first located the site in 1980. The site was previously described and photographed in a BLM report prepared by Continental Shelf Associates.

Site E2. This site, located approximately 1 nautical mile from sites D and E1 (see Fig. 1), was searched for 6 hours without detection of a magnetic anomaly. The lack of an anomaly indicated that no well was drilled in this area. Data for a well at that location are not included in any published

geological cross sections, and cuttings, cores, and electrical logs are not available. This was probably a permitted well which was never drilled. The State of Florida has no record of a well at that location.

Because of poor weather conditions, an additional nearby site not on the original MMS list, but shown in Table 1, was searched.

Site B26-Y (State Lease Block). This site is located 4.5 nautical miles to the northeast of the Marquesas Keys within Boca Grande Channel, where the water depth is 15 to 18 ft. Tidal currents in this channel are strong, and at the time, water visibility was less than 6 ft. During summer months, however, water visibility in this area is 15 to 20 ft.

A strong anomaly was detected at Loran C TDs 13905.4 and 43729.1 (Table 1), less than 1,000 ft from where the initial search buoy was placed. After deploying several buoys, the zone of maximum magnetic anomaly was defined, and divers, including MMS observer Less Dauterieve, inspected the bottom. The site consisted of a 36"-diameter conductor pipe filled with cement and cut off flush with the bottom. The area was surrounded by metallic debris, cable, and a 4-ft length of 36"-diameter conductor pipe lying adjacent to the wellhead. Because of extreme currents and poor water visibility, the underwater search was halted after discovery of the wellhead. A permanent buoy was tied to the 4-ft length of conductor pipe lying 2 ft from the wellhead.

Site A. This site is located beyond sight of land, and the information provided by MMS indicated a water depth of 110 ft.

An Oil and Gas Journal article describing the well indicated, however, that the water was 36 ft deep. After reaching the correct coordinates, the water depth was found to range between 35 and 40 ft. Apparently, the 110-ft number represents the distance from the kelly bushing to the bottom. The 15,294-ft well was drilled from a large 14-leg jackup rig that stood at least 70 ft above the water surface, which would account for the discrepancy.

Two and one-half days were required to find and document the well site. The principle difficulty was current strength and direction along with the abundance of lobster traps marked with long north-south-floating lines that made it virtually impossible to run east-west search lines. The magnetometer fish was nearly lost on several occasions because of entanglement with trap lines. On the second day, the search area was enlarged, and a second central search buoy was placed about a quarter of a mile from the first, using slightly different latitude and longitude coordinates provided by the State of Florida. On the third day, however, the current-direction changed, and an east-west magnetometer search parallel to the floating trap lines was made possible. The large anomaly shown in Figure 2 was encountered less than 1,000 ft from the original search buoy. Winds had reached 30 knots by the time the anomaly was found, but a quick examination by snorkeling showed it was the well site. After

"Porous Coral Possesses Problem": v. 58, no. 14, p. 30, April 4, 1960.

being driven into port for 2 days, we revisited the site and three scuba dives were made for observation, photography, video, and simple measurements.

Figure 3 is a scale drawing of the site. Note that confirmation is provided by 15 geometrically arranged, circular, sand-filled depressions, each 15 to 16 ft in diameter. The site, measured with a tape measure, consists of two groups of four depressions and two groups of three, totalling 14 depressions. This arrangement conforms exactly with the photograph of the drill rig shown in the Oil and Gas Journal. The fifteenth depression, located at one end and between the two groups of four, conforms with the location of the drill tower. The casing was not visible but is assumed to be buried beneath the sand. Adjacent to this depression is a pile of twisted coral- and sponge-encrusted cable.

The water was very clear, and the circular sand-filled depressions were clearly visible from the boat and should be visible from an airplane. Apparently, the pads on the bottom of the legs depressed the hard bottom 1-2 ft. The depressions, encircled by a 6- to 10-in. rock lip, were filled with rippled coarse reef sand, which has prevented recolonization by a hardbottom community. Cuttings were not visible; however, they undoubtedly exist within the coarse sand. The lack of a cuttings pile can be attributed to two factors: (1) storms may have dispersed them and (2) the well was drilled with aeriated water, which tends to pulverize the rock. Drill mud was not used until the bit reached about 10,000 ft. According to the drilling report, drill mud was used at that depth to help bring cuttings

to the surface, an indication that cuttings return throughout the drilling must have been less than normal. Cuttings can probably be found by examining bottom sand samples under a binocular microscope.

Other than the physical damage caused by the legs and casing hole, the bottom looked the same as nearby hardbottom areas.

SUMMARY

All the sites were marked with permanent buoys tied to the bottom and accurate Loran C TDs were taken at each site. The Loran C data are shown in Table 1. The sites can easily be reoccupied even if the buoys are missing. Physical damage is fairly obvious, although the total area affected is small. What is yet to be determined is whether there was biological damage caused by drilling fluids and cuttings and whether the fauna has recovered to predrilling conditions. In the case of site D-E1, fish life is more abundant than in the adjacent area, because the cement bags and other debris provide shelter and thus serve as an artificial reef. The bottom fauna has been modified and, as pointed out in the BLM report, the alga Halimeda is abundant, whereas the surrounding area has more alcyonarians and less Halimeda. This change is probably due to the blanket of pebbles that covers the hard substrate.

The two remaining sites to the west of the Marquesas should not be difficult to find, given calm weather. One (site C) was drilled with the same 14-legged rig (Rig 52) that drilled well A; thus, the impressions made by its legs should confirm the site once a magnetic anomaly is found. The other well, the so-called

Rebecca Shoal well, was drilled from a floating barge (the NOLA-3). Drilling records show the barge was moved off location several times because of weather and at one point left the site for several months to drill well D. Difficulties continued and even after the well was re-entered, the well at site C was eventually abandoned. Because of the time spent by the barge on and off the site, there will probably be an abundance of debris to help locate the spot. We intend to search these sites in June or July of 1988. In addition, we feel that for environmental reasons the well in Florida Bay is extremely significant. This site should be located and a survey of its effects made.

APPENDIX

PERSONNEL

Captain Roy Gaensslen (charter)

Jack L. Kindinger (USGS)

J. Harold Hudson (USGS)

Barbara H. Lidz (USGS)

Eugene A. Shinn (USGS)

Less Dauterieve (MMS)

CRUISE ACTIVITIES

10/26/87 (Day 1)

2030 hrs - Depart Crandon Park Marina, Key Biscayne, Florida,
with Gaensslen and Kindinger on board

0000 - Anchor at Caesars Creek for night

10/27/87 (Day 2)

0700 - Underway

2010 - Arrive Oceanside Marina, Stock Island, Florida;

Hudson joins cruise

10/28/87 (Day 3)

1000 - Depart Oceanside Marina after unloading gear and taking on fuel

1315 - Arrive site E1; commence search pattern

1630 - Debris located; Hudson ground-truths area

1740 - Depart site for lee of Marquesas for night

10/29/87 (Day 4)

0745 - Underway to site E1 to search for site D

1600 - Site D located; Hudson ground-truths area

1700 - Depart site for lee of Marquesas for night

10/30/87 (Day 5)

0800 - Underway to site E2

0830 - Sea state 3; 25-knot winds, 3-4' seas, abort travel to site E2 and return to Oceanside Marina

1210 - Arrive Oceanside Marina

10/31/87 (Day 6) - Oceanside Marina

Hudson and Kindinger return to Miami; tropical storm moves across Key West October 31 to November 3

11/01/87 (Day 7) - Oceanside Marina

11/02/87 (Day 8) - Oceanside Marina

11/03/87 (Day 9) - Oceanside Marina

1530 - Kindinger, Dauterieve, and Lidz arrive Oceanside Marina, shop for and onload ship's stores

11/04/87 (Day 10)

0845 - Depart Oceanside Marina for site E2

1130 - Arrive area of E2 and begin search

1730 - Depart for anchorage at Marquesas; search for E2
abandoned

11/05/87 (Day 11)

0845 - Weather poor for offshore work; depart for site
826-Y in Boca Grande Channel

0915 - Commence search for well site 826-Y

1230 - Site located; Kindinger and Dauterieve ground-truth

1700 - Depart for anchorage at Marquesas; weather
deteriorating

11/06/87 - (Day 12)

0700 - Front has arrived; winds north 25-30 knots, seas 2-
4 ft and building

0915 - Depart for Oceanside Marina

1300 - Arrive Oceanside Marina; Kindinger returns to Miami

11/07/87 (Day 13) - Oceanside Marina

11/08/87 (Day 14) - Oceanside Marina; Shinn joins cruise

11/09/87 (Day 15)

0830 - Depart Oceanside Marina with Lidz, Shinn, and
Dauterieve

1335 - On site of well A searching with no luck

1715 - Return to Marquesas for night

11/10/87 (Day 16)

0710 - Depart Marquesas for well site A

0915 - On site; continue search

1710 - Depart for Marquesas anchorage

11/11/87 (Day 17)

0845 - Underway as front moves in.

1230 - Site A located in 5- to 7-ft seas and 30-knot winds;

Shinn ground-truths by snorkeling

1345 - Depart for Oceanside Marina, taking blue water over
bow of boat!

1830 - Arrive Oceanside Marina

11/12/87 (Day 18)

1615 - Depart Oceanside Marina for Marquesas anchorage

1915 - Arrive Marquesas for night

11/13/87 (Day 19)

0900 - Depart anchorage for buoyed site of E1 to wait out
weather

1200 - Return to anchorage for duration

11/14/87 (Day 20)

0830 - Depart Marquesas for well site A

1020 - Arrive site A and prepare for ground-truthing

1040 - Dauterieve and Shinn dive 20 minutes

1110 - Dauterieve and Shinn dive 20 more minutes

1240 - Dauterieve and Shinn make 1-hr dive

1520 - Depart site A and head for anchorage

11/15/87 (Day 21)

0645 - Depart anchorage for well site C

0900 - Abort travel due to rapidly deteriorating weather and
return to anchorage

1515 - Depart anchorage for Oceanside Marina

1810 - Arrive Oceanside Marina

11/16/87 (Day 22)

0820 - Drive Dauterieve to Key West airport. Continuation of
cruise postponed until weather improves in late spring.

Shinn and Lidz drive to Miami.

11/17/87 (No-charter day) - Oceanside Marina

11/18/87 (No-charter day) - Oceanside Marina

1200 - "Captain's Lady" underway

11/19/87 (No-charter day)

1830 - "Captain's Lady" arrives Crandon Park Marina, Key
Biscayne

FIGURE CAPTIONS

Figure 1. Bathymetry of Marquesas Keys area showing locations of wells (dry hole symbols). Note two wells are located approximately 200 ft apart at the D-E1 site. Well E2 to the south of site D-E1 was never drilled. Note location of well A 12 nautical miles southwest of the Marquesas Keys. Wells C and B to the west of site A have not yet been located and documented. Site B is located off the map.

Figure 2. Print magnetometer anomalies associated with wellhead casings. Note that anomalies are well over 30 gammas and shift of anomaly from left to right (positive to negative) or vice versa indicates sensor passed almost directly over wellhead. Numbers are the last 4 digits of Loran C TDs.

Figure 3. Scale map of site A showing the 14 sand-filled depressions (black circles) corresponding to arrangement of the 14 legs that supported the jackup rig (Rig 52). Note additional sand-filled depression between end leg holes which corresponds with position of the well bore.

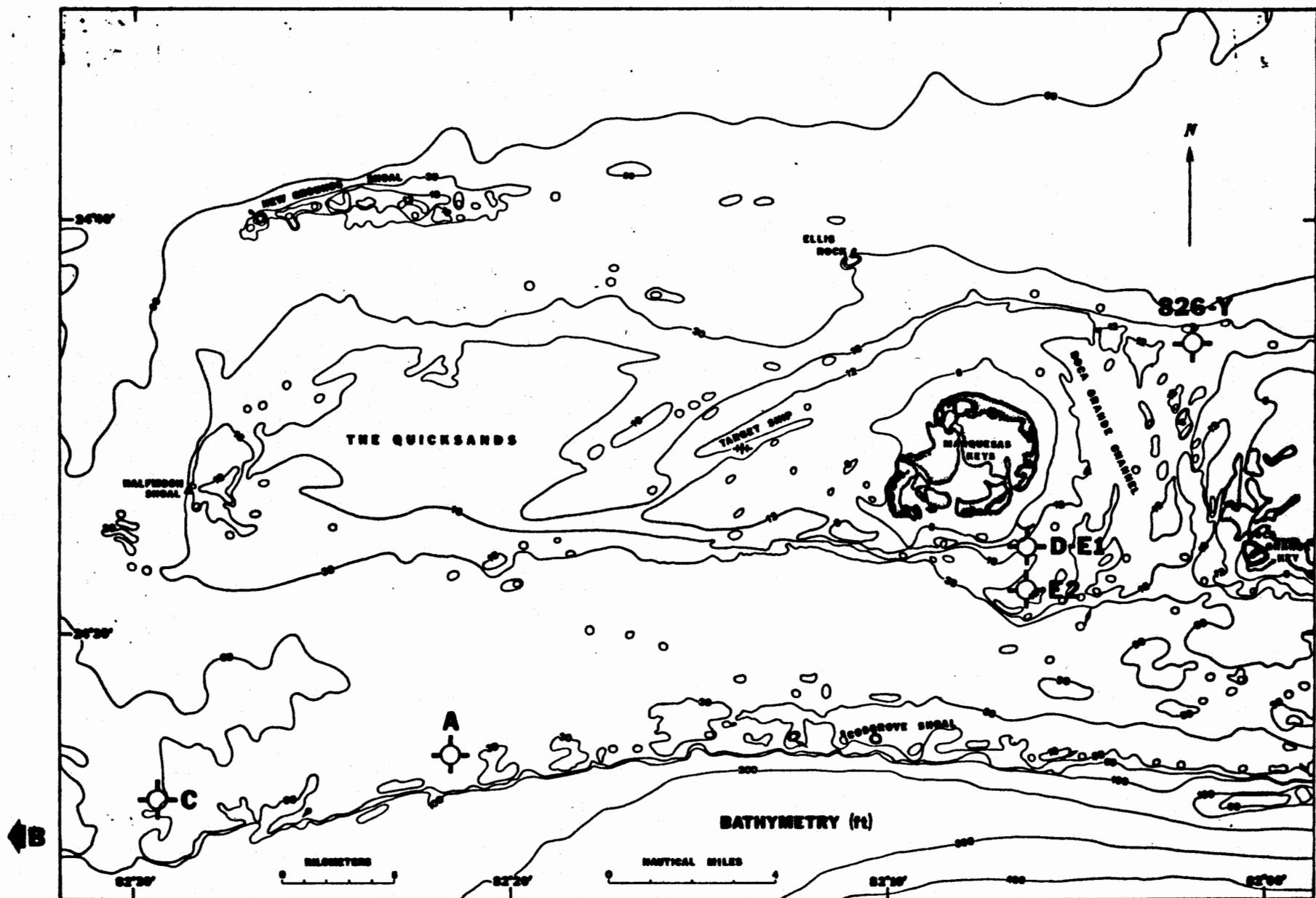
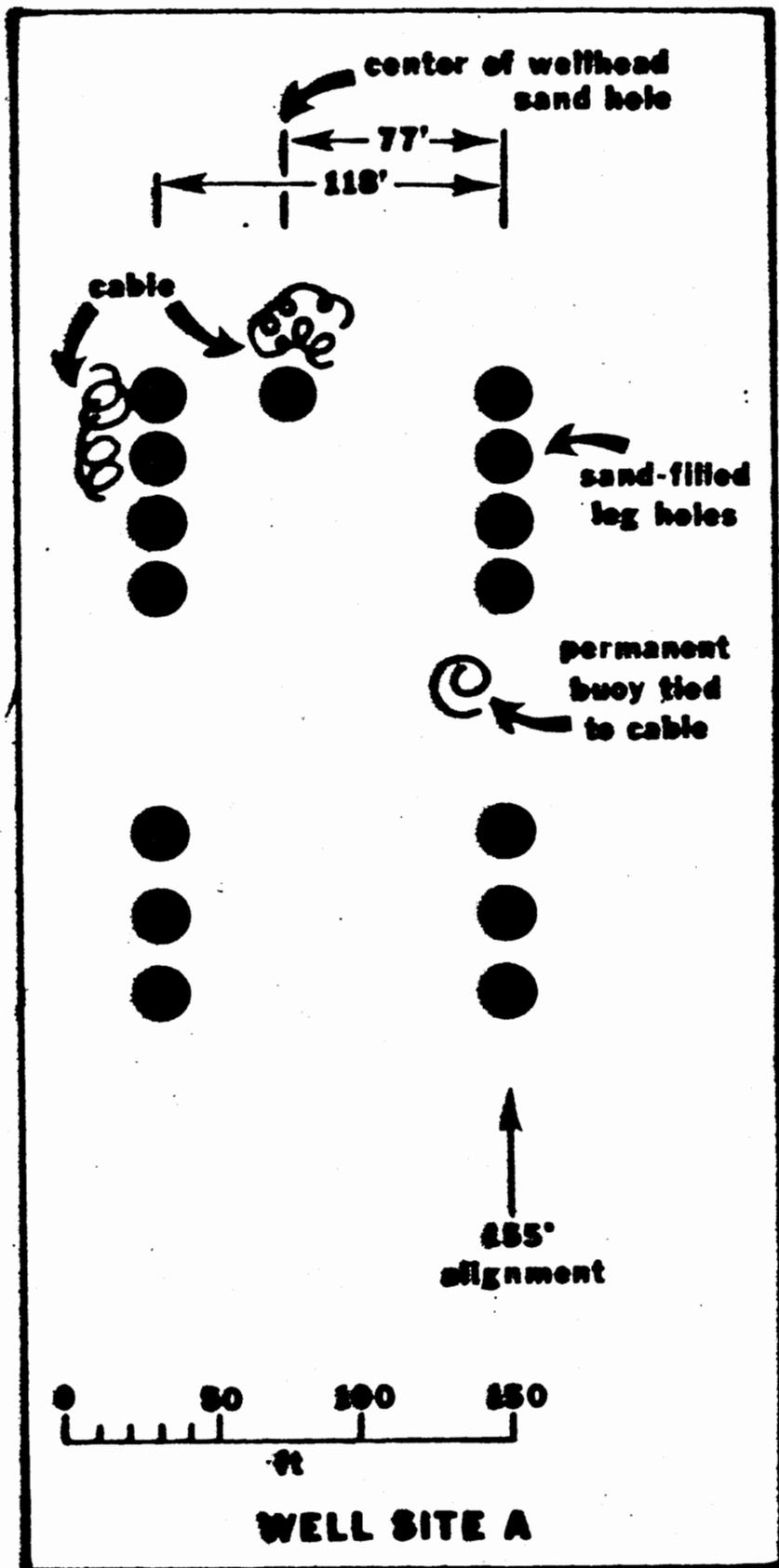


Fig 1

TABLE 1. WELL SITES FOR THE FLORIDA KEYS DIVING SURVEY

Well Name	Loran C TDs	Latitude/Longitude	Date Drilled	Rig Type	Water Depth (ft)	Well Depth (ft)	Lessee
*A	13845.7 43826.8	24°27'10" 82°21'67"	1960	Jackup	35-40	15,294	Offshore Co.
B		24°25'22" 82°36'03"	1961	Barge	62 or 100	4,687	Gulf & Calif. Co.
C		24°26'02" 82°29'30"	1961	Jackup	55-60	7,871	Offshore Drilling
*D	13887.9 43748.5	24°32'11" 82°06'42"	1961	Barge	15	7,723	California Co.
*E1	13887.9 43748.5	24°32'11" 82°06'42"	1962	Pontoon	15	12,850	California Co.
E2		24°31'01" 82°06'31"					
*826-Y	13905.4 43729.1	24°37'08" 82°02'23"	1959		15-18	14,702	Gulf Oil Corp.
826-G		29°82'86" 66°27'29"	1955			12,631	Gulf Oil Corp.

*Well sites located by U.S. Geological Survey in October 1987. Loran C TDs, Latitude/Longitude, and water depth are actual and true coordinates/measurements.



WELL SITE A

Fig 3