

## ADDITIONAL EVIDENCE RELATING TO "A WORLDWIDE STORM OF MICROSEISMS WITH PERIODS OF ABOUT 27 SECONDS"

BY JACK OLIVER

### ABSTRACT

The hypothesis that the worldwide storm of ultralong period microseisms in early June 1961 was caused by ocean swell of the same periods striking the coast of the Gulf of Guinea is supported by mariners' observations of unusual swell and its effects at the places and times predicted by the hypothesis.

In a recent paper (Oliver, 1962) an unusual storm of ultralong period microseisms detected by seismographs distributed over much of the world was reported and discussed. Data from one station, Palisades, where instruments with exceptional sensitivity to these waves are operated, showed that the storm lasted at least two days, emerging from background at about 0800 GMT on 6 June 1961, and gradually merging with background at about 0600 GMT on 8 June 1961. On the assumption that the seismic waves were of the Rayleigh type, the source was located in or near the equatorial or southern Atlantic Ocean. Two hypotheses for the source mechanisms were then proposed. The prime hypothesis attributed the seismic waves to impact on the coast of Africa in or near the Gulf of Guinea by dispersed ocean waves (or swell) of the same period as the seismic waves. The dispersion of the ocean waves was consistent with generation by a meteorological disturbance in the South Atlantic at a distance of about 65 degrees from the African Coast on the 2nd of June. Such a storm was observed just north of South Georgia Island by the R/V Vema. An alternative hypothesis, less well supported but not in conflict with any available evidence, attributed the seismic waves to magmatic activity beneath the southern Atlantic Ocean.

At the time the paper was written, no observations were available to the author on marine phenomena along the coast of the Gulf of Guinea for the pertinent dates. As a result of publication of the paper, new data have been found and they support strongly the hypothesis of generation of seismic waves by ocean waves of the same period incident upon the coast of the Gulf of Guinea. The new data consist of copies of portions of deck logs for several ships in the area at the time of the storm, a copy of a letter from the Master of the SS AFRICAN MOON, Captain J. X. Stanejko, to the Marine Superintendent of Farrell Lines, Inc., the firm owning the ship, and a letter in response to the author's request from Captain W. G. Todman, a Master Mariner now Harbour Master at Takoradi, Ghana, who observed the storm and its many effects while on shore duty in the port of Tema, Ghana. The following is a summary of pertinent remarks in the logs and the letters. Only selected portions of each are quoted. All times are local but are usually equivalent to GMT and, in any case, never differ from GMT by more than one hour.

#### *The deck log of the SS AFRICAN SUN, 5-10 June 1961*

The AFRICAN SUN, while at dock in Point Noire, Congo reported "Vessel surging heavily" at 2400 on 5 June and 0800 on 6 June. While en route from Point Noire to

Lagos, Nigeria, in generally mild weather (wind force 4 or less), she reported as follows: 0800 7 June—"long low S×E swell," 1200—"Heavy SSW swell," 2000—"Low S'ly swell," 2400—"mod. SW swell," 0800 8 June—"short mod. SSW swell." At 1000 she reports "Heavy gale and rain," at 1200—"heavy swell" and at 2000—"Mod. sea & swells." No further observation of swell was reported on 8 or 9 June. She anchored outside Lagos at 2230 8 June and entered Lagos Harbor about 0800 on 9 June.

*The deck log of the AFRICAN DAWN, 5-10 June 1961*

The AFRICAN DAWN, at anchor off Takoradi, Ghana, experienced a brief local storm during the first two hours of 5 June. She reports "Heavy sea & swell—no boat service" at 1100 on 5 June and "Heavy sea & swell—No launch," at 1600 on 5 June and 0800 on 6 June. At 1200 on 6 June she was at dock in Takoradi and reports no further observations of swell.

*The deck log of the AFRICAN GLEN, 5-10 June 1961*

The AFRICAN GLEN, at anchor off Monrovia, Liberia, reports: 0400 7 June—"Vessel rolling in long low swell," 1200—"Short high SW swell." 1600—"Average high SW swell," 2000—"Low SW'ly swell," 2400—"Low SW swell," 0400 8 June—"Long mod. swell," 0800—"Long mod. swell," 1200 and 1600—"High long S'ly swell." During this period no winds stronger than force 3 were reported, except during a brief rainstorm. At 1900 on 8 June, the vessel shifted into the protected harbor.

*The deck log of the SS AFRICAN MOON, 5-10 June 1961*

The AFRICAN MOON was at wharf in Tema, Ghana, but the harbor clearly did not provide complete protection from the sea during this storm. From 1800 on 6 June through 0800 on 9 June the AFRICAN MOON repeatedly reports "Vessel surging heavily" as a result of heavy swell in the harbor. During this interval a total of 16 mooring lines or wires were parted, and damage of several types was done to the vessel through contact with the wharf.

*The letter from the Master of the SS AFRICAN MOON*

The letter of Captain Stanejko, which unfortunately is too long to reproduce here, gives a more thorough and more graphic account of the AFRICAN MOON's experiences in the storm than does the deck log. It describes a local meteorological storm late on 4 June and a local northeasterly storm on 6 June. Ranging (fore and aft motion) and surging (up and down motion) of the vessel began just prior to 1515 on the 6th, when additional mooring lines were set, and continued through 7 and 8 June. The northeaster ended early on 7 June. During the early portion of the storm, prior to 8 June, swells broke over the eastern breakwater and later over the main breakwater to the south. The harbor entrance is to the east. During the storm the breakwater of a small fishing harbor to the east of the main harbor was broached in two places by heavy seas. Part of the main harbor's western breakwater slid into the sea.

One paragraph of the letter describes the statement of a local authority, Captain W. G. Todman, on the magnitude of the storm at Tema. He repeated these remarks

in essence, and provided additional information in the letter which is the subject of the next section.

*The letter from Captain W. G. Todman*

This letter was sent to the author following his request for more information on the storm. It is so relevant that a substantial portion is quoted.

“As I am now stationed at Takoradi I cannot confirm the exact dates of the unusual sea conditions at Tema, but Captain Stanejko’s dates are most probably correct. I agree that at the time the wave conditions were the heaviest experienced since the construction of Tema Harbour commenced in 1954 and reports from Takoradi and Abidjan confirmed that the conditions were the worst on record.

“There is always a swell on this coast which increases during the South Atlantic winter, April–September. Storms are rare in this area except for an occasional tornado which does not affect the swell but sets up a slight sea which subsides within hours of the centre passing. The tornados are not as severe as you experience in the States, in fact they could, in my opinion, be called severe thunderstorms only. We have no indication when the swell will increase here. One day will be reasonably quiet, and on the next day a heavy swell will be causing the ships in the harbour to surge about and seas will be breaking over the breakwater. These conditions last 4 to 7 days which probably is connected with a previous storm period in the South Atlantic. During Geophysical year, we took recordings of wave conditions on the coast of Ghana, and as a result I enclose three papers which will probably be of interest to you. . . .

“The heavy swell which appears to have been experienced all along the coast of the Gulf of Guinea in June 1961 set up a surge in Tema Harbour which in the area of number one (1) berth, a corner berth, amounted to approximately one foot. As a result vessels were surging up and down the wharves and continually breaking ropes. Damage was done to wharves by the ships, and they themselves, the “African Moon” especially, suffered damage from bumping the quay. The Pilots reported a heavy swell when boarding vessels outside the harbour, and a rough measurement estimated the swell at about 11 feet from trough to crest. The breakwaters were at times completely covered by the breaking seas. The very bad conditions lasted a little under forty-eight hours though it was noted that the swell was increasing four or five days before, and that it decreased over a period of three or four days after the peak period.

“At Takoradi we occasionally have to take oil tankers off the berth in the months April–September due to the swell conditions. On this occasion a tanker had to be moved out to anchor and a vessel at the bauxite berth also had to be moved to anchor. It is the only occasion on record of having to clear the bauxite berth.

“I understand the Port of Abidjan was closed for two days. The Port Captain wrote to us asking if we had any way of getting warning of these heavy swell conditions. The only help we could give was to suggest radio messages from Ascension Island when they experienced unusual swell conditions there.”

These documents contain at least three types of information which support the theory of generation of this storm of microseisms by ocean swell generated some distance from and incident upon the African Coast. The first type consists of obser-

vations of swell and its effects by seamen aboard ships either at sea or in port, at about the time and place predicted by the theory. The second is the observation that the storm as manifested by the swell was unusually severe yet not greatly dissimilar to other smaller storms. This is in agreement with observations at Palisades, the only station with data adequate to show that the 6 June microseism storm was unusually large and that other smaller storms occur regularly. The third is that a fairly large portion of the coast was affected at about the same time as would be expected for swell traveling a great distance. The distance from Abidjan to Tema is almost 300 miles and this figure, of course, represents only the limit of the information available to Captain Todman and probably not the limit of the storm's effects, which may well have extended at least as far west as Monrovia, and as far east as Point Noire. Captain Todman's suggestion concerning a warning system based on observations at Ascension would, incidentally, appear to be quite sound.

The observed effects, particularly at Tema, may include not only the results of the incidence of ocean swell from the distant source but also the action of local meteorological disturbances, which appeared in parts of the area at the time. As Captain Todman points out, the long swell could hardly be attributed to such sources but the damage at Tema might have been less if the two effects had not been partially concurrent. Certain observations also suggest that swell may have begun to strike the coast prior to the beginning of the microseism storm at Palisades and to have continued beyond the observed termination. This discrepancy might well be due to insufficient instrument sensitivity or poor signal-to-noise ratio, or it might be that other swell unrelated to this problem because of its lower energy or different period range was observed. The tendency suggested by a few observations for the swell to approach from the southeast during the early portion of the storm, rather than the southwest, might be accounted for on this basis, or on the basis of lateral refraction with the longer and earlier waves being most affected. Wave interferences within the harbor would, of course, affect the AFRICAN MOON's observations.

It is regrettable that quantitative instrumental data on ocean waves are not more generally available. Apparently no wave recorders are now operated on the entire southwest coast of Africa, although there has been at least one short-lived installation in Ghana (Darbyshire, 1957). Swell period which would be of great value is not usually quoted in deck logs. The logs sometimes give estimates of amplitudes and direction of propagation, but both of these may be strongly affected by bottom topography in shallow water. Many other difficulties arise when working with qualitative observations only. As an example, one maritime authority at one African port, when queried by mail, reported confidently a complete absence of abnormal sea conditions during the month of June 1961, a statement which is impossible to reconcile with the abundant evidence to the contrary for this same port.

In spite of these difficulties, a convincing case can be made in support of the theory of generation of ultra long period microseisms by ocean swell of the same periods, and there can be little doubt that much, though certainly not all, seismic noise in this period range is a result of this process.

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