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THE AGADIR EARTHQUAKE OF FEBRUARY 29

By ERNEST TILLOTSON

THREE slight earth tremors during the previous week were not considered premonitory of the earthquake which suddenly occurred near Agadir at about 11.40 p.m. on the night of February 29, 1960, since this district had not previously experienced an earthquake of intensity 10 on the ten-degree scale. However, at 23h. 40m. 12s. U.T., after preliminary rumbling, the shock occurred. 90 per cent of the Talborjit quarter where many Moroccans lived in multi-storied apartment buildings, 70 per cent of the new buildings, including the Saada Hotel, built only five years ago, and the Gautier Hotel, and 20 per cent of the industrial buildings collapsed. Agadir, the tourist and economic capital of southern Morocco, where the Atlas Mountains descend to the Atlantic Ocean, was ruined. Some 12,000 people, including 3,000 foreigners, were estimated to have lost their lives, and many thousands besides were injured. A seismic sea wave (tsunami) which reached some 300 yards inland from the coast and then retreated, added to the damage.

There was no electric supply and there were no telephones; sporadic fires occurred as the fires in buildings were scattered about; the sanitary and water systems were utterly destroyed. The headquarters building for the militia collapsed with loss of life, but the police headquarters remained standing. Moreover, there were only a few police in the buildings during this night of Ramadan. An orphanage for about a hundred children was shattered; the hospital was badly damaged, and the maternity ward destroyed. Sailors from the French naval air base some $2\frac{1}{2}$ miles away were quickly on the scene, and their prompt action saved thousands trapped under the ruins.

The ancient Casbah, inhabited by some 500 people, built about the year 1540 on high hills above the port, was destroyed. The shock was felt strongly in Mogador, about 100 miles to the north.

King Mohammed put his son, the Crown Prince Moulay Hassan, in charge of all necessary operations. Total evacuation of the population was ordered, the dead buried, and rescue operations for those trapped were continued. The injured were evacuated to hospitals in other parts of Morocco, and tented camps were erected, a large one being between Agadir and the Moorish town of Inezgane, 7 miles south-east of Agadir, which itself suffered some 30 per cent damage. Many buildings left unstable by the earthquake have been demolished and, since epidemics, especially of typhoid and plague, were feared, a 5-week quarantine was ordered. The ground has been spread where necessary with quicklime and 800 tons of DDT have been sprayed on the area.

At the port of Agadir all cranes collapsed with the falling-in of the quays and jetties, except on the main jetty. The principal cargo sheds were damaged, the harbourmaster killed and both pilots injured.

Evidence of a tremendous submarine upheaval off the coast was obtained from preliminary naval soundings. In one case the depth of water was found to be 45 ft. where previously it was charted at 1,200 ft. In a position about 9 miles from the shore, soundings showed a depth of 1,200 ft. instead of the charted 4,500 ft. An extensive hydrographic survey will thus be required, especially near the harbour, where some dredging was necessary even before the earthquake.

The shock was registered by seismographs at observatories throughout the world (Durham University Observatory, England, *iPz* 23h. 45m. 44s. *D*, *iSE* 23h. 50m. 21s. U.T.), and the United States Coast and Geodetic Survey placed the preliminary epicentre at lat. 30° N., long. 9° W. Small aftershocks have continued to occur, one at about 22.30h. on March 3, one about 00.01h. on March 4, two on March 5 and one on March 6.

The *Times* reported "an informed source" as stating that the insurance coverage in London for Agadir was expected to be a good deal short of one million pounds, "as North Africa is not regarded as a dangerous area for earthquakes" and as Agadir is basically under French influence and dealt with by French insurance companies. However, any rebuilding which may be undertaken at or near the present site of Agadir must now take earthquake risk into account. Earthquake damage at a given place depends on the properties of the elastic waves arriving there, on the ground at the site shaken, and on the structures involved. The ratio of amplitudes at sites on fairly dry alluvium more than 500 ft. deep to those at sites on crystalline rock is frequently 5:1, or more for earthquake waves of period 1-1½ sec. For waves of period about 0.1 sec. and for waves having periods exceeding 10 sec. (length more than 10 miles) the differences in amplitude are small. Amplitudes of earthquake waves at sites on water-saturated soft ground may be ten times those on crystalline rock. The period of waves giving the maximum ratio decreases to a quarter of a second for places with alluvium about 100 ft. thick. Moreover, at sites on alluvium the length of time of shaking also increases. Ground effects may produce these appreciable differences in duration and amplitude even at localities only a fraction of a mile apart. The importance of choosing crystalline rock or at least dry ground, and of avoiding water-saturated soft ground for foundations of buildings in order to reduce potential earthquake damage, cannot be over-emphasized.