last October

7.3 quake in Algeria reviewed

After a devastating earthquake struck northern Algeria last October, killing more than 5,000 people and leaving 200,000 homeless, Algeria's Ministry of Education & Scientific Research invited a team from the U.S. Geological Survey to study the quake's surface effects. Here is a report based on field investigations Nov. 5–15.

An earthquake of surface-wave magnitude 7.3 struck at 13:30 CDT on Oct. 10, near El Asnam. Its epicenter was at 36.17°N, 1.36°E, and its depth of focus was about 6 km, as calculated by the National Earthquake Information Service, in Denver. The epicenter was about 170 km west of Algiers and about 45 km south of the Mediterranean coast, near the northern boundary of the African Plate. The after-shock sequence included several strong-to-moderate shocks, dominated by a magnitude-6.0 earthquake 3 hours after the main shock. The widespread destruction left El Asnam and adjacent communities devoid of all but emergency services for about 10 days.

A similar sequence of earthquakes occurred in September 1954 in the vicinity of El Asnam (magnitude-6.7 main shock on Sept. 9). At least 10 moderate to large earthquakes have occurred in the El Asnam region in the last 250 years, and the region therefore has a serious continuing seismic risk.

Last October's earthquake sequence was associated with primary faulting on a reverse or thrust fault that generally emerged along a 32-km-long surface break as a low-angle thrust. The surface breaks associated with the main thrust and various secondary faults were irregular in detail and not so continuous as indicated by the general representation on the map. The main surface break strikes about N42°E and dips between 8° and 25° to the northwest at most sites. However, dips as high as 60° were estimated or measured at a few sites, and those values are more consistent with a dip of 55° to 60°, given by the fault-plane solution for the main shock, according to S.T. Harding. In that respect, the 1980 El Asnam earthquake was similar to the earthquake of Feb. 9, 1971, in the San Fernando Valley of California.

The central and northeast sections of the main break were along the base of the steep southeast slope of a ridge about 200 m high, northwest of Oued Fodda. The maximum vertical component of displacement, measured across scarp produced by thrust movement on an 8-km central section of the main break, was 2.6 m near Oued Fodda, so that, given an assumed dip of about 30°, a maximum dip-slip of more than 5 m would be...
represented (3.4-m dip slip assuming 50° dip). However, the scarp heights at most sites along the 8-km central section of maximum displacement adjacent to Oued Fodda were about 1.0 to 1.4 m, and a more representative estimate of dip slip at the surface thus would range from 2 to 3 m. The surface expression of thrusting died out a few kilometers northeast of a change in strike to N68°E along the main break. That bend in the fault trace coincided with a similar change in the trend of the base of the slope marking the northwest side of Oued Chéïiff valley.

An irregular zone of secondary normal faulting and extensional features such as grabens developed roughly parallel to the central and northeast sections of the main thrust break within 1 to 2 km to the northwest, and extended for about 15 km along the same trend, beyond the northeast end of the surface expression of thrust faulting. Scars along the normal faults above the shallow part of the thrust were generally more conspicuous, if not larger, than those along the trace of the main break.

A complex zone of predominantly normal faulting occurred in the vicinity of the village of Beni Rached, within the hanging-wall block of the thrust, about 6 to 7 km northwest of the main thrust break. Most of the surface fractures in that area were probably produced by secondary faulting, although a few are related to landslides. Scarp heights produced as a result of slip on normal faults just west of Beni Rached typically were slightly less than 1 m (vertical offset) but ranged up to 1.26 m. The accurate pattern of surface breaks near Beni Rached, associated with the 1980 earthquake sequence, nearly duplicates the fracture pattern mapped by Jean-Pierre Rothé and his colleagues ('Le tremblement de terre d'Orléansville et la seismicité de l'Algérie', La Nature n. 3237, p. 1-9, January 1955).
during a field investigation of the 1954 earthquake sequence. Several of the recently reactivated fractures showed displacements in the same sense and of similar amplitude to those noted 26 years ago.

A fault-plane solution for the main shock in 1954 indicated thrusting on a northwest-dipping surface having a northeast strike, according to Dan McKenzie ('Active tectonics of the Mediterranean region,' Geophysical Journal of the Royal Astronomical Society, v. 30, p. 109–185). Similar fault-plane solutions are derived from teleseismic data for the recent main shock and principal aftershock (strike N42°E, dip to NW at 55° to 60°, as reported by S.T. Harding). Those solutions reinforce the suggestion, based on the observed regeneration of the pattern of surface fractures near Beni Rached, that the 1954 and 1980 earthquake sequences may have originated on the same structure or structures, even though no field evidence was reported in 1954 for surface breakage along the trace of the thrust fault.

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Near Beni Rached (S), the normal-fault scarp is 1.26 m high. (Photo by Robert O. Burford.)