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THE MELOUZA (ALGERIA) EARTHQUAKE OF 21 FEBRUARY 1960

Abstract. The Melouza earthquake of 21 February 1960 is one of the largest earthquakes, in terms of casualty and damage, that the Hodna region has experienced since the beginning of this century. The main shock, which lasted about 5 seconds, caused the loss of 47 lives, injured 129 and rendered approximatively 4,900 homeless (about 700 families); it destroyed about 600 housing units. The poor quality of the constructions and their low resistance to seismic forces are the main causes of the high damage rates in Algerian earthquakes. The earthquake was felt in an area of about 20,000 km^2. Macroseismic data retrieved from contemporary sources show that the area most affected was the whole zone between Melouza and Beni Ilman where the main shock exhibited maximum intensity at I_o = VIII (MSK). From the intensity data, an isoseismal map of the main shock was drawn and a macroseismic epicentre located, at 36.03 °N, 4.17 °E, between Melouza and Beni Ilman. The surface-wave magnitude was calculated at M_S=5.10 (± 0.30). Although the damage and casualties were reported as due to the main shock, the possibility of cumulative damage from the heavy rain and earlier aftershocks remains. According to the different sources available, the main shock was not preceded by any foreshock or any other premonitory signs. On the other hand, the earthquake was followed by a long sequence of aftershocks. The 1960 Melouza earthquake also triggered important landslides and rockfalls. The total cost of damage was estimated, at the time, as 500 million French Francs. This work shows that source documentary materials must be analyzed with great care with respect to the socio-economical situation, demographic conditions as well as the religious and cultural backgrounds. This work is directly related to the importance of the seismic characterization of the mediterranean basin for disaster mitigation and emergency planning in the region.

INTRODUCTION

The Melouza earthquake of 21 February 1960 occurred in the Djebel Choukchott, which is one of the secondary chains of the Tell Atlas and lies between the Hodna and Titteri ranges. In terms of the region's seismic history, we found no information for important earthquakes in the past in this particular restricted area of the plain. However, this region for seismotectonic reasons should be considered as seismic as the whole Tell Atlas. Moreover, it is known that the coastal ranges, the mountains of the interior Tell and the Saharan Atlas are by turn and periodically sites of earthquakes of different sizes. According to the region's seismic history reported by Chesneau (1892), Rothé (1950,1962, 1969), Hée (1925, 1950), Karnik (1969) Mezcua and Martinez (1983) and recently Benhallou (1985), the seismicity of the Hodna has been very low during the last two centuries. Only three destructive earthquakes are reported this century: Melouza 1960, Berhoum 12 February 1946 (Ms = 5.55 (±0.17)) which claimed 277 lives, injured 118 and destroyed about 1,000 housing units (Grandjean, 1954; Benouar, 1993), and M'sila 1 January 1965 (5.45 (±0.20)) which caused the loss of 5 lives, injuring 25 and destroying 3,145 houses (Grandjean et al., 1966; Benouar, 1993).

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The methodology used in this study is essentially that developed by Ambraseys and Melville (1982).

The reconstruction of the macroseismic field of the Melouza earthquake is of great interest for the following reasons: firstly, it represents the only destructive earthquake to have occurred and been studied in the Melouza zone in the last two hundred years, according to sources available to us. Secondly, the epicentral area of the Melouza earthquake displays today many of the geographical and human characteristics found in other seismic zones in Algeria and therefore, a careful analysis of the effects of this event is pertinent to the whole of Algeria in terms of seismic hazard and risk evaluation.

The Melouza earthquake occurred at 8h 13mn on the 21 February 1960 in the western part of the Hodna region. It caused heavy damage to the douars of Melouza and Beni Ilman, and their surroundings. According to the collected macroseismic data, the epicentre is located between Melouza and Beni Ilman. Maximium intensity reached has been re-evaluated at I_0 = VIII (MSK) and covers an area of about 12 km radius. The earthquake was felt, in a relatively small area of about 20,000 km^2, as far as Alger, M'sila, Bordj Bou Arreridj, Bouira, Dra El Mizan and El Adjiba (Fig. 1). The surface-wave magnitude Ms of this event was calculated, using the Prague formula, to be 5.10 ($\pm$0.30). The main shock, which lasted about 5 seconds, caused the loss of 47 lives and injured 129, most of them women and children; it destroyed about 600 housing units (Archives du Gouvernement General, 1960) rendering approximately 4,900 homeless. The earthquake produced important fissures, landslides and rockfalls in the region, particularly north of Melouza, where large fissures were reported. Significant to slight damage was observed in an area of about 40 km radius around Melouza. The relatively low casualty rate is mainly due to the time of occurrence: in the first place, at the time of the shaking, all the men, the majority farmers, were already in their fields and thus escaped the disaster. Secondly, as in other douars, much of the daily life takes place in the courtyards or in the gardens, which saved many women's lives. Mostly old people and children were caught in the houses when the earthquake struck.

The widespread destruction of the traditional native houses (gourbis) is due rather to the poor quality of the constructions (adode, drystone,heavy thatched or tile roofs), their low resistance to earthquakes and their degree of deterioration rather than the severity of the ground shaking. It is important for the macroseismic field reconstruction to mention that the region of Melouza was hit by a strong snowstorm in January 1960 which destroyed or weakened a number of adobe houses.

For a better re-evaluation of the strength of shaking, an extensive investigation of source documentary materials was carried out to reveal what type of constructions existed and in what state they were in, in order to add to the macroseismic information collected and thus to reassess intensities with a certain degree of reliability.

SOURCES OF INFORMATION

Despite the significance of this event for the region, however, it is surprising to find that no complete scientific study has been carried out except that of Rothé (1960, 1962, 1969) who summarized briefly the casualty rate and damage, without quoting his sources. Benhallou (1985) briefly, using Rothé as his source, outlined the event in few lines. It had been thought that the documentation on this earthquake would be abundant, particularly in the press, as for past earthquakes in the region. Unfortunately, this was not so; the information was very limited. This lack of information was clearly due to the military situation of the region (Algerian Liberation War). Reports in the Algerian and International press (1960) were our main source of information. The most extensive account is given by the Journal d'Alger which describes extensively the damage as well as the climatic and political situation of the period. Many photographs published by the newspapers and taken shortly after the earthquake show the extent of damage caused, particularly to the traditional houses. In recent catalogues, maximum intensity attributed to this event is VIII(MS), Grandjean (1960); IX(MSK), Mezcua and Martinez (1983) and VIII(MM) Benhallou (1985). Some agencies have also attributed a maximum in-

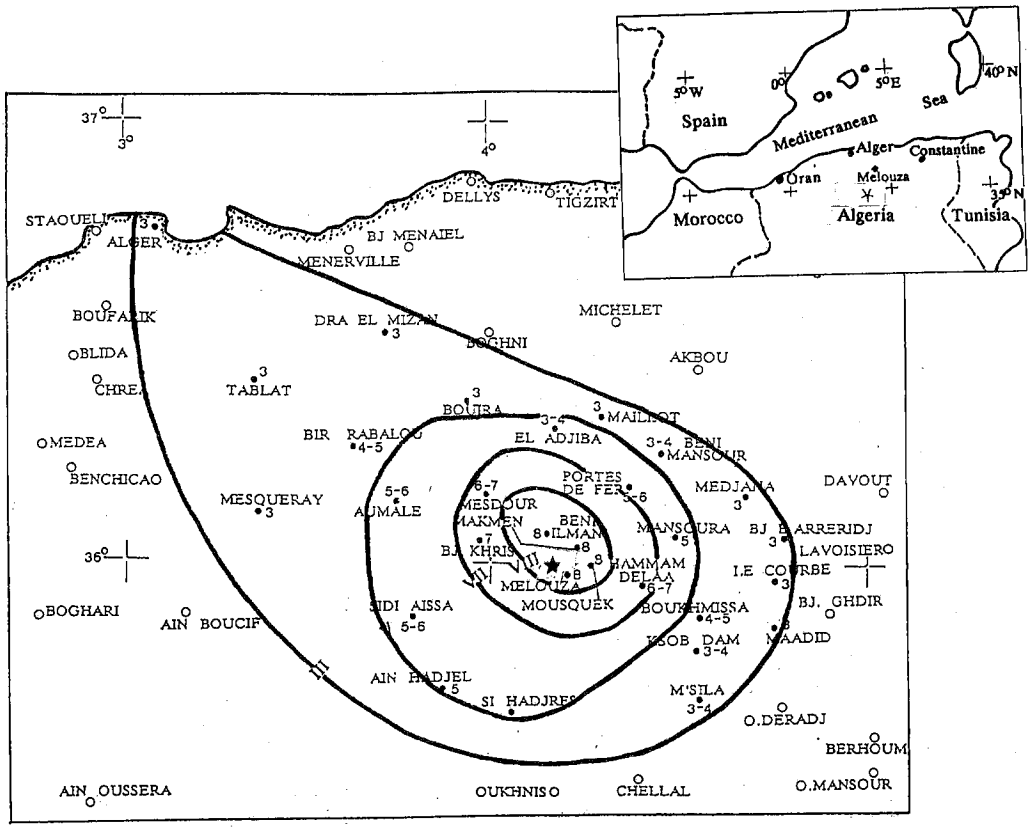

Fig. 1 - Isoseismal map (MSK scale) of the main shock of the 21 February 1960 earthquake. The star shows the macroseismic epicentre of the main shock.

tensity of IX(MM), [IMPGA]; IX(MSK), [SSIS] and VIII-IX(MM), [BCIS]. Epicentral locations were given at 35.870°N, 4.170°E (ISS); 36.00°N, 4.50°E (USCGS, MOS); 36.00°N, 4.10°E (BCIS) and 35.652°N, 4.250°E (SSIS). Magnitudes were also determinated as 5.90 (Lwiro); 5.75 (Pasadena and Matsushiro); 5.60 (Benhallou and Roussel,1971); 5.5 (Grandjean, 1960); 5.1 (Pruhonice); 5.00 (Collmberg); 4.75-5.00 (Moscow); 4.6 (Praha) and m_b=5.6 (Kew) and 5.5 (Mezcua and Martinez, 1983).

GEOGRAPHICAL ASPECTS OF THE REGION

The relief of northern Algeria is characterized by the Tertiary folds of the Atlas ranges. These consist of two main chains separated by the High Plateaux: the Tell Atlas and the Saharan Atlas. The two chains are distinct in western Algeria, but they approach each other gradually and merge in Tunisia. In eastern central Algeria, the two principal ranges are linked by branches, notably the Hodna ranges which come between the High Plateaux and the High Plains of Constantine. The Hodna ranges form a succession of massifs of complex structure. The main crests of the Hodna are Djebel Dira (1,810 m), Djebel Choukchott (1,854 m) and Djebel Mansoura (1,864 m).

The Hodna plains, together with the Sebkha and the Rmel, form, in the centre of the country, a wide closed basin surrounded by mountains ranges. Isolated from the coast by 100 to 150 kilometres of mountain ranges, the Hodna plains are dry and hot, which gives them very close to a desert climate. Geographically, this plain is an integral part of the High Plateaux, and from west to east they succeed each other (Despois, 1953). The Hodna plain is not only

Table - List of sites with re-estimated intensities.

Intensity	Site
VIII	Melouza, Beni Ilman, Mousquek and Makmen
VII	Bordj Khris
VI-VII	Mesdour and Hammam Delaa
V-VI	Aumale, Portes de Fer and Sidi Aissa
V	Ain Hadjel and Mansoura
IV-V	Boukhmissa and Bir Rabalou
III-IV	Ksob Dam, El Adjiba, M'Sila and Beni Mansour
III	Alger, Tablat, Bouira, Medjana, Dra El Mizan, Maillot, Bordj Bou Arreridj, Le Courbe, Maadid and Mesqueray
Not felt	Boufarik, Blida, Chrea, Benchicao, Boghari, Ouled Deradj, Ain Boucif, Oukhnis, Bordj Ghdir, Lavoisier, Boghni and Menerville

a vast topographic depression but also an important tectonic basin, which is subsiding to the east of the meridian of Bou Saada. This is an old trench of subsidence of which the depth was recently revealed by gravimetric measurement by Lagrula (1951).

DAMAGE AND CASUALTY DISTRIBUTIONS

In order to re-assess the damage and thus re-estimate the intensity with a certain degree of reliability, a comprehensive search for documents relative to this earthquake was carried out in libraries and archives in both Algeria and England. All the information retrieved, from the sources available to us, give evidence on the total destruction of traditional houses in the epicentral zone. The most important macroseismic information contributing to the reconstruction of this event are presented in what follows.

Melouza, located 140 km southeast of the capital Alger, is on the southern flank of Djebel Choukchott which culminates at over 1,800 metres (Bernard, 1929). This douar accommodated in 1960 about 6,000 inhabitants (Armature Urbaine, 1987-1988), living in houses mostly of adobe or drystone and with heavy thatched or tile roofs, generally loaded with rocks to resist better the winds. This agglomeration is only 60 kilometres from the city of M'sila, but is off a dangerous country hilly road, which did not help the relief operations. French army helicopter pilots, who flew over the hit area described Melouza and its immediate vicinity as a heap of earth and dust (Press, 1960). On the southern flank of Kef Soumar mountain, which overhangs the douar in the north, huge fissures, rockfalls and lanslides were observed. The main shock caused widespread destruction of the douar and seriously undermined the spirit of the population. Women, children and old people were seen screaming and fleeing their homes, afraid of being buried under the rubble. The whole population was terrified and camped in the open, fearing other shakings. Many of the victims, taken by surprise inside their houses, were simply buried under the debris of their homes. The sky over Melouza was covered by a very dense dust from the destruction of the houses and the ground itself. The earthquake caused the loss of 8 lives and injured 65 others (Press, 1960). Houses were observed split in two. It is reported that 70 percent of the houses of Melouza were completely destroyed, but loss of life was less than at Beni Ilman (Fig. 2). Among the 6,000 inhabitants of Melouza, it is believed that 572 families (about 3,600 people) were rendered homeless (Press, 1960). The douar of Beni Ilman, which is located about 5 km south of Djebel Choukchott, was immersed in total stupor and terror. A witness reported at this douar, "I thought that the mountain had exploded. We heard a huge explosion in the mountain and then everything was shaking, including the mountain and the ravine". Another witness said "... a few seconds before the shaking, my tethered horse broke his fastening and fled to the countryside". Many people saw a red ball passing over the mountains. Some inhabitants saw "white smoke" coming out of the mountain (Press, 1960); in fact, it was the landslides and rockfalls, caused by the shaking on the mountain that provoked a very thick cloud of dust. The population was panic stricken as the women, the children and the old people were screaming and rushing out, fleeing from their collapsing houses into the open fields. The centre of this douar looked as though it had

Fig. 2 - The scope of the disaster at the douar of Melouza (Ph. Journal D'Alger, Press reports, 1960).

been devastated by heavy bombing, as described by the local press (1960). Here the earthquake caused the loss of 39 lives, injuring 64 and making 1,300 homeless; it destroyed completely about 50 percent of the constructions of this douar (Fig. 3). The whole population slept in army tents and eat canned food for several days after the shaking. In the Mosque of Mechta-Casbah, which was used as a school for teaching the Koran, 15 children were buried under its debris and 9 of them were found dead. The ruins of the Mosque are shown in Fig. 4. The newly built army post (SAS: Security and Administrative Service) was also reduced to ruins. The toll of injured, reported to be 64, of which 21 were seriously hurt, was not communicated in detail. It is important to mention that a violent snowstorm had already destroyed a school and caused damage to Beni Ilman in January 1960 (Press, 1960).

The douars of Mousquek and Makmen, located between Melouza and Beni Ilman, experienced significant damage. Some of their houses were completely destroyed, while others presented serious cracks, but no casualties were reported. Bordj Khris, 20 km west of Melouza, suffered the collapse and serious damage of some housing units. At Sidi Aissa and Ain El Hadjel, about 40 km southwest of Melouza, the houses sustained slight damage, such as cracks in walls and fall of roofs. Forty-five kilometres northwest of Melouza, the colonial village of Aumale was slightly hit; only small cracks were reported in some houses or gourbis. The earthquake was strongly felt east of Melouza, at the junction of the Hodna and the Bibans mountain ranges, south of Portes de Fer. The shaking was reported up to Alger, Bouira, Beni Mansour, Bordj Bou Arreridj, Medjana, M'sila, Mesqueray,etc.. Felt reports which correspond to lower intensities are given only for important cities or colonial villages. A list of sites with re-estimated intensities is presented in the Table. We found no evidence that the shock was felt at or beyond Boufarik, Blida, Ain Boucif, Chellal, Bordj Ghdir, Lavoisier, Boghni, Oukhnis, Bordj Ghdir and Akbou (Fig. 1).

The re-estimation of the intensity of the shaking was done, (see the Table) after much analysis of the data, with reference to the Medvedev-Sponheuer-Karnik (MSK) scale (1981). The constructions of the region, at the time of the earthquake, were adobe or drystone houses with heavy thatched or tile roofs. This widely diffused type of construction (type A as defined by

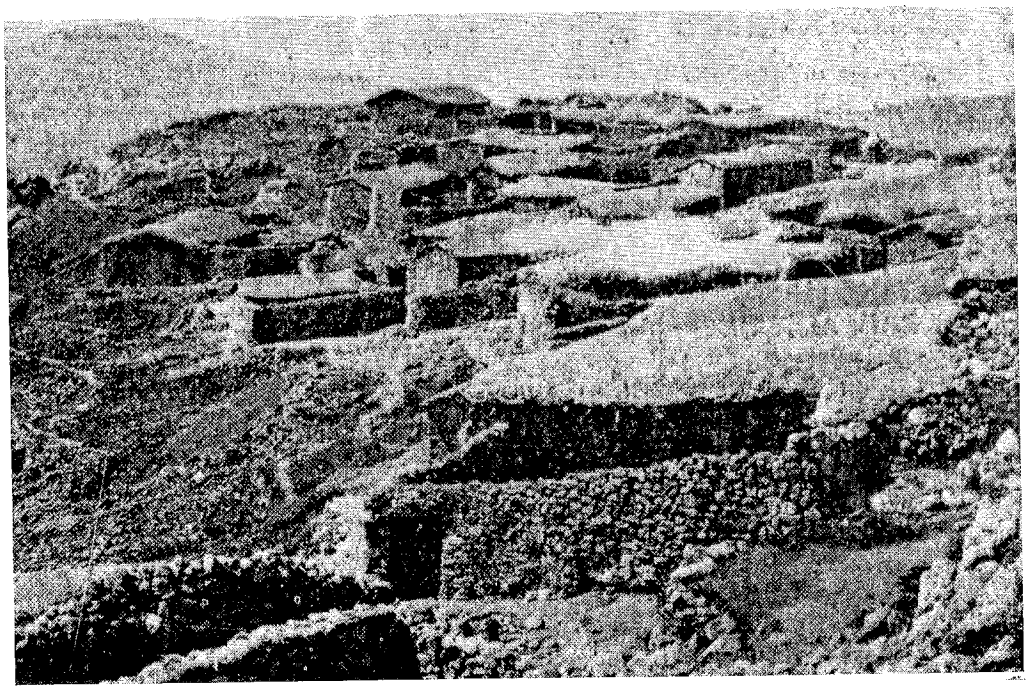

Fig. 3 - The extent of damage at the douar of Beni Ilman (Ph. Echo D'Alger, Press reports, 1960).

the MSK scale) had shown in the past, as in many other parts of Algeria, very low strength and high vulnerability to earthquakes or even rain. Therefore, the degree of damage caused to these dwellings is an indication of the weakeness of the structures rather than the strength of the ground shaking. As a conclusion, at intensity IX (MSK), most of the houses are totally destroyed, and any douar would thus look equally devastated at higher intensities. For this reason and according to the macroseismic data collected, it is unlikely that intensity IX was clearly reached.

After much analysis of the different parameters that may have contributed to the destruction of these douars, maximum intensity was re-estimated at VIII and was allocated to the whole area between Melouza and Beni Ilman. This intensity was assigned to the zone associated with maximum damaged structures and loss of life.

As a result of the analysis of the macroseismic data, an isoseismal map of the main shock of the Melouza 21 February 1960 earthquake is shown in Fig. 1.

MAGNITUDE DETERMINATION

Teleseismic amplitude and period readings of the main shock were reported from 9 seismological stations at epicentral distances between 6° and 22°. The surface-wave magnitude of the earthquake was calculated with the standard Prague formula (Vanek et al., 1962) using a preliminary epicentre (macroseismic) at 36.036°N, 4.175°E. The mean period is 13 seconds and the derived value of M_S, without station corrections, is 5.10 ($\pm$0.30). The details are presented in Benouar (1993).

FORESHOCKS AND AFTERSHOCKS

No foreshock was felt, according to the seismological station records of the region and to the population of the affected zone. There are reports of other phenomena, such as unusual

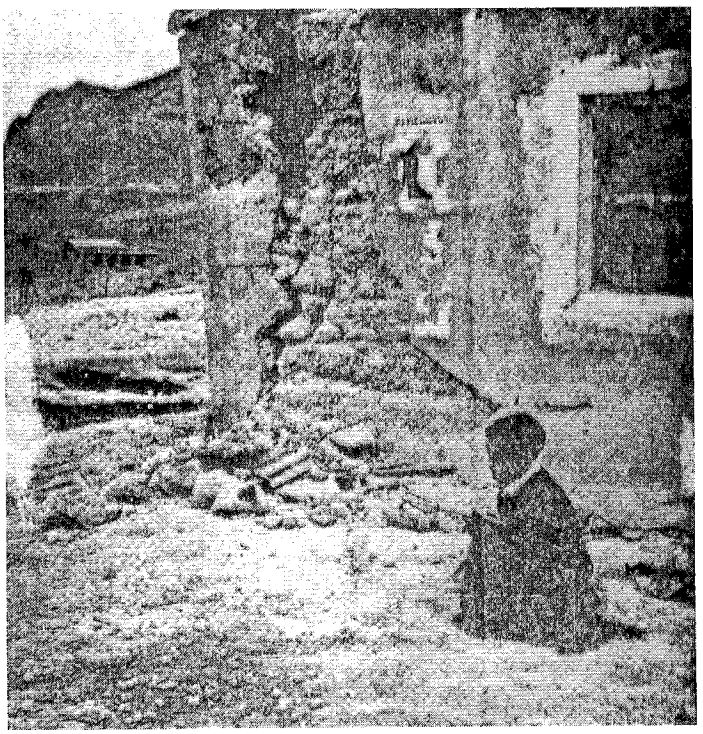

Fig. 4 - Shows the damage caused to the Mechta-Casbah Mosque, where 9 children died under the debris of the roof (Ph. Echo D'Alger, Press reports, 1960).

animal behaviour, which could have been premonitory.

In the other hand, the main shock was followed by a long sequence of aftershocks of much less intensity continuing until 25 February. There were 3 early aftershocks at 9h 15mn, 10h 30mn and 12h 30mn. The first one accentuated the damage to the houses seriously affected by the main shock (8h 13mn), but the second and the third completed the destruction (Press,1960). These aftershocks created a sensation of insecurity which seriously undermined the spirit of the population for a few days.

DISCUSSION

In terms of the seismic history of the region, according to Chesneau (1892), Rothé (1950, 1962, 1969), Hée (1925, 1950), Karnik (1969), Mezcua and Martinez (1983) and recently Benhallou (1985), we found no information about any destructive earthquake that had occurred, in the last two hundred years, at this particular site of the Hodna. Through the history of the region, the area and its population centres have suffered a lot and seem to have been partly demolished more than once during their existence (Gsell, 1902), probably by earthquakes. Vestiges of the impounding of water and antique canalizations still remain near important springs. Also, several remnants of the past, such as dams, irrigation quanats, and particularly, the ruins of Kelaat Beni Hammad are still visible and should be studied in detail. Today, archaeoseismology and palaeoseismology techniques could be used in the Hodna region to reveal any destructive earthquakes and to extend the time range of the seismic history.

This earthquake is the largest felt and recorded earthquake in this part of the Hodna. It occurred on the southern flank of Djebel Choukchott, which constitutes one of the secondary chains of the Tell Atlas and lies between the Hodna and the Titteri ranges. Despite the scattered population density in the region, the isoseismals in Fig. 1 show a predominant NE-SW

direction, which corresponds clearly to that of Djebel Choukchott. This event constitutes a new focus which is not shown in any previous historical seismicity map. It is of interest to note that the most important earthquakes in the Atlas took place at the border between subsiding basins and regions tending to rise (ex. M'sila 1965 and Berhoum 1946). Thus, the cause of the Melouza 1960 earthquake may be associated with the epirogenic uplift of the Hodna mounts with respect to the surrounding subsiding basins defined by Lagrula (1951). A recent work on the geology of the seismic zones in northern Algeria by Meghraoui (1988) gives some details on the active tectonics of the region.

Macroseismic data collected, mainly from Algerian newspapers, confirm that the most strongly affected area lies between Melouza and Beni Ilman. On the MSK scale, the main shock exhibited a maximum intensity in the range of VIII-IX, within an area of 12 km radius. On first analysis, we were tempted to assign an intensity IX but, considering carefully the building characteristics of the region, we were convinced that the extensive damage was much more associated with the high vulnerability of the constructions rather than the severity of ground shaking (Rothe', 1960). After critical analysis of the data collected, maximum intensity I_o=VIII(MSK) was assigned to the area comprised between Melouza and Beni Ilman. This intensity is lower than that allocated by some other writers and agencies. Although most damage was reported as due to the main shock, there remains the possibility of cumulative damage from early aftershocks and rain.

In order to understand better the importance of this event and the macroseismic data collected from the contemporary documents, it is necessary that historical accounts be analyzed in the whole context of the political and socio-economic situation, demographic conditions, buildings characteristics, together with the religion and cultural background of the period concerned, and in particular, the density and the distribution of population in the affected zone (Ambraseys et al., 1983). The number of victims is certainly higher than officially reported, since many people were buried under the rubble of their houses in several scattered douars which were never reached by the relief teams. We believe that the exact toll of casualties may never be known, since many victims were immediately interred to conform to Islamic law and never reported to, or somehow neglected by, the French authorities. The whole affected area, shortly after the earthquake, was declared a disaster zone, thus falling under the full authority of the army, implying automatically censure of news. Some press reports mentioned about 308 victims at Beni Ilman but, at present, we can find no other source to confirm it. The Melouza earthquake occurred at the height of the Algerian Liberation War (1954-62), which was much more active in eastern Algeria; this situation prevented the press and even the French army from visiting isolated douars in surrounding valleys and mountains. The French administration controlled totally only important douars, which may explain why information reported was limited to large douars and surrounding towns. The fact that this earthquake coincided with the war period was a real disadvantage in terms of casualty and damage reports; many douars, sparsely distributed in valleys and on the flanks of surrounding mountains, which could have enriched the data, were not mentioned in any contemporary documents.

In similar situations, it is of great interest that macroseismic data be inferred also from contemporary military sources which, because of their official character, contain ample and reliable information. Lack of critical analysis of civilian and military historical sources definitely leads to gross misjudgement of the effects of the earthquake. Additional search for eventual damage and casualty details continues.

Reconstruction of macroseismic fields of historical events presents a fundamental basis for the establishment of seismic hazard, particularly in Algeria where the frequency of destructive earthquakes is low.

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REFERENCES

Ambraseys N.N. and Melville C.P.; 1982: *A history of Persian earthquakes.* Cambridge University Press, Cambridge, 219 pp.

Ambraseys N.N. et al.; 1983: *Notes on historical seismicity.* Bull. Seis. Soc. Am., **73**, 1917-1920.

Archives du Gouvernement General, Alger.; 1960: Report of the Melouza 21 February 1960 earthquake (unpublished).

Armature Urbaine; 1987-1988: *Statistiques.* Vol. 4, Série S.R.C., 3 e Trimestre. Office National des Statistiques, Alger.

Benhallou H. and Roussel J.; 1971: *Catalogue des séismes Algériens de 1951 à 1970.* Note IMPGA, N° **3**, Alger.

Benhallou H.; 1985: *Les catastrophes séismiques de la région d'Echeliff dans le contexte de la séismicité historique de l'Algérie.* Thése de Doctorat Es-Science, IST-USTHB, Alger.

Benouar D.; 1993: *The seismicity of Algeria and adjacent regions during the twentieth century.* Ph.D thesis, Imperial College, Civil Engineering Dpt., London, 500 pp.

Bernard A.; 1929: *L'Algérie.* Librairie Felix Alcan, Paris, 522 pp.

Chesneau M.; 1892: *Note sur les tremblements de terre en Algérie.* Annales des Mines, Neuviéme série, tome **I**, 5-46.

Despois J.; 1953: *Le Hodna (Algérie).* Publications de la faculté des lettres d'Alger. II eme serie, tome XXIV, Presses Universitaires de France, Paris.

Grandjean A.; 1954: *Séismes d'Algérie de 1940 á 1950 inclus.* Annales de l'IPG de Strasbourg, tome VII, **3**, 63-85.

Grandjean A.; 1960: *Bulletin séismique mensuel.* Inst. Meteor. et Phys. du Globe d'Algérie, Alger.

Grandjean A., Guiraud R. and Polveche J.; 1966: *Le séisme de M'sila.* Bulletin du service géologique de l'Algérie, N°. **33**, Alger.

Gsell S.; 1902: *Atlas archaéologique de l'Algérie et enquete administrative sur les travaux hydrauliques anciens.*

Hée A.; 1925: *La Fréquence des tremblements de terre en Algérie 1911-1924.* Monogr. Bur. Centr. Seis. Inter., Serie B, Fasc. **2**, 111-154.

Hée, A.; 1950: *Catalogue des séismes Algériens de 1850 á 1911.* Ann. Inst. Phys. Globe, tome **6**, 41-49, Strasbourg, France.

Karnik V.; 1969: *Seismicity of the European Area.* Part 1. Dordrecht, Holland, 364 pp.

Lagrula J., 1951: *Etude gravimétrique de l'Algérie-Tunisie.* Bull. Serv. Carte Géol. Algérie, 4 eme série, n° **2**.

Medvedev S., Sponheuer W. and Karnik V.; 1981: *Report of the ad-hoc panel meeting of experts on the updating of the MSK-64 seismic intensity scale.* Gerlands Beitr. Geophys., **90**, 261-268.

Meghraoui M.; 1988: *Géologie des zones sismiques du Nord de l'Algérie (paléosismologie, tectonique active et synthése sismotectonique).* Thése de Doctorat d'Etat, Université de Paris-Sud, Centre d'Orsay, France.

Mezcua J. and Martinez J.M.; 1983: *Sismicidad del area Ibero Mogrebi.* Seccion de Sismologia, Inst. Geogr. Nacional, Madrid.

Press reports; February-March 1960: L'Echo D'Alger, Dimanche Matin, Le Journal d'Alger, La Dépêche de l'Est, Dernière Heure, La Dépêche Quotidienne (Algeria); Le Figaro, Le Monde, L'Humanité (France); The Times (UK); The New York Times (USA).

Rothé J.P.; 1950: *Les séismes de Kherrata et la séismicité de l'Algérie.* Bull. Serv. Cart. Geol. Algérie, 4 e Série, Géophysique, N° **3**.

Rothé J.P.; 1960: *Le tragique bilan des séismes de 1960 incombe en majeure partie à la mauvaise qualité des constructions.* La Nature, N° **3305**, 378-387.

Rothé J.P.; 1962: *Tableau de la séismicité du globe pendant l'année 1960. Chroniques séismologiques.* Revue pour l'Etude des Calamités. Bull. de l'Union Intern. de Secours, **38**, 21-56.

Rothé J.P.; 1969: *The seismicity of the Earth 1953-1965.* UNESCO Earth. Sc. Report, Paris, 336 pp.

Vanek J., Zapotek A., Karnik V., Kondorskaya N.V., Riznichenko Yu.V., Savarensky Ye.F., Solov'ev S.L. and Shebalin N.V.; 1962: *Standardization of magnitude scales.* Invest. Akad. Nauk. Ser. Geofyz., **2**, 108-111.