ÉCOLE DOCTORALE SCIENCES DE LA TERRE

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TITRE du SUJET: History of the earthquake ruptures along the Dead Sea Fault. From observation to numerical simulations

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Développement du Sujet : (1 à 2 pages)

The Dead Sea fault (DSF), also named Levant fault, is one of the major active faults in the Eastern Mediterranean basin. About 1200km long, this left-lateral strike-slip fault accommodates the differential motion between the Arabic plate, to the East, and the Sinai micro-plate, to the west. The fault is quite linear over its entire length with two major exceptions. One exception is the extensional jog that forms the proper Dead Sea. The other exception is the compressional bend that gives rise to the Lebanese mountain range, which tops almost at 3000m high. Few other bends could be observed along the DSF, but none are of a similar size. The Lebanese bend corresponds to a deflection to the East of the fault of about 15°. Due to such a drastic change of azimuth, some of the motion accommodated across the DSF becomes compressional. Recent results from fieldwork have shown that the compressional motion and the horizontal motion remain partitioned along different parallel faults that are well identified in Lebanon. The horizontal motion is mostly accommodated by the Yammouneh fault and some secondary strike-slip faults to the East, while the thrust motion is accommodated by a thrust-and-fault belt located off-shore Lebanon. South of the Lebanese bend, a series of two basins interpreted as being small releasing steps, of 10 to few 10's of km in size have been identified.
In addition to a good understanding of the current geometry of the different faults in this area, in the recent years the long-term slip rate of each of these faults has been worked-out using neo-tectonic methodologies. More important, the earthquake history of the various fault segments starts to be better known, thanks to paleoseismological investigations at different sites, which come to complement the rich regional historical record. In several points along the different segments we have identified without ambiguity the last, and possibly the penultimate, earthquake that affected the site. This identification, site by site, of which earthquake has affected which site will continue to progress at the pace of the paleoseismological investigations, over several years.

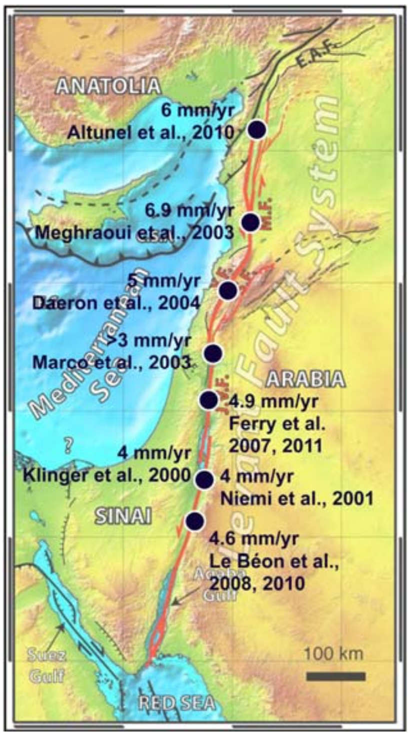
Because this region is largely inhabited with several large cities in short distances (Damascus, Jerusalem, Beyrouth to cite only a few), understanding how earthquakes propagate and relate to each other in space and time is of primary importance to improve the regional seismic hazard.
Hence, we would like to address here a series of questions related to the dynamic of the earthquakes in this region, based on our knowledge of the historical events:

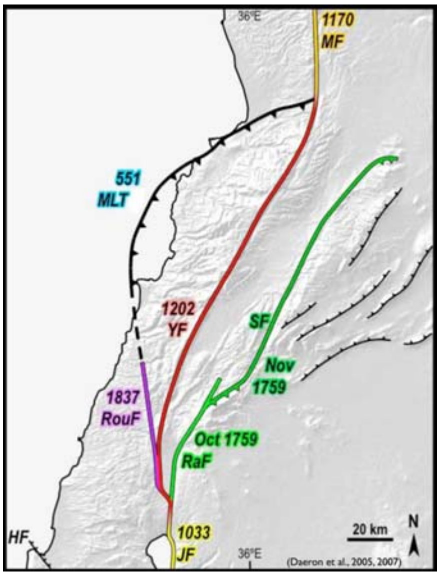
Q1: It is known that the AD 1202 (M>7.5) rupture went along the Yammouneh segment in Lebanon and it is also well documented South of the Hula basin. Incorporating the actual geometry of the faults (bends and existing secondary branches), into numerical models, we propose to run various rupture scenarios to see if some of the scenarios would be more probable than others, in light of the local geometry.

Q2: In addition to the largest earthquake known in the area, the AD 1202 event, the timing of the latest rupture is also known for most of the other faults of the area. Hence, the question is: could we decipher some rupture pattern that would make some sense to explain the observed sequence of events. Does directivity of ruptures could play a role in the temporal sequence of ruptures and in this specific case could we try to construct a scenario to describe the sequence of earthquake.

Q3: In many places around this area, castles have been built, either by the Crusaders or by the Arabs. A systematic survey of the remains of the castle seems to indicate that destructions are not random or even. A pattern of destruction, that needs to be better appreciated, suggest that some asymmetry exists in the distribution of destructions, relative to the location of the fault. Considering that the DSF is formed by a succession of long linear fault segments, such uneven distribution could result from some effects of super-shear rupture propagation, which would be responsible for more rupture along one side of the fault compared to the other.

The first task would be to evaluate the static stress distribution for the geometrically complex fault system shown in Fig. 2. Using these stress distributions, we propose to address the above questions by appealing to the Boundary Integral Equation Method. This numerical technique allows one to model dynamic shear rupture propagation along a geometrically complex fault system. The tasks would involve evaluating several rupture propagation scenaria and estimating associated ground motions.





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