Modern Seismic Network Development in Iraq

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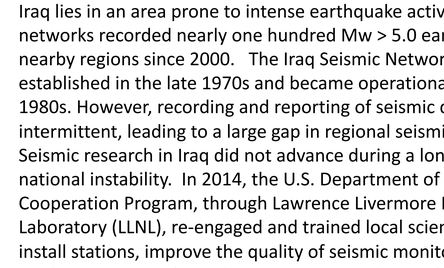
ABSTRACT

Iraq lies in an area prone to intense earthquake activity. Global networks recorded nearly one hundred Mw > 5.0 earthquakes in nearby regions since 2000. The Iraq Seismic Network was established in the late 1970s and became operational in the early 1980s. However, recording and reporting of seismic data has been intermittent, leading to a large gap in regional seismic data collection. Seismic research in Iraq did not advance during a long period of national instability. In 2014, the U.S. Department of Energy's Seismic Cooperation Program, through Lawrence Livermore National Laboratory (LLNL), re-engaged and trained local scientists in Iraq to install stations, improve the quality of seismic monitoring, and modernize seismic hazard mapping in Iraq. Currently, the Iraq Seismological Observatory, including participants from Iraqi universities and other research organizations, operates eleven broad-band seismic stations in Iraq. Six of these stations provide open data to the international community (three in real-time) through the Incorporated Research Institutions for Seismology's (IRIS) Data Management Center (DMC). LLNL has collaborated extensively with Iraqi experts on modernizing seismic hazard maps based on a new Probabilistic Seismic Hazard Assessment. In 2017, the Iraqi government incorporated the updated hazard maps into new seismic design criteria in the national building code.

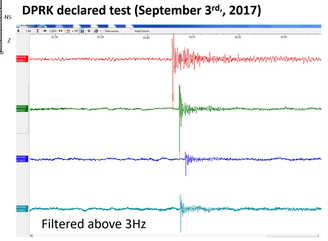
BACKGROUND

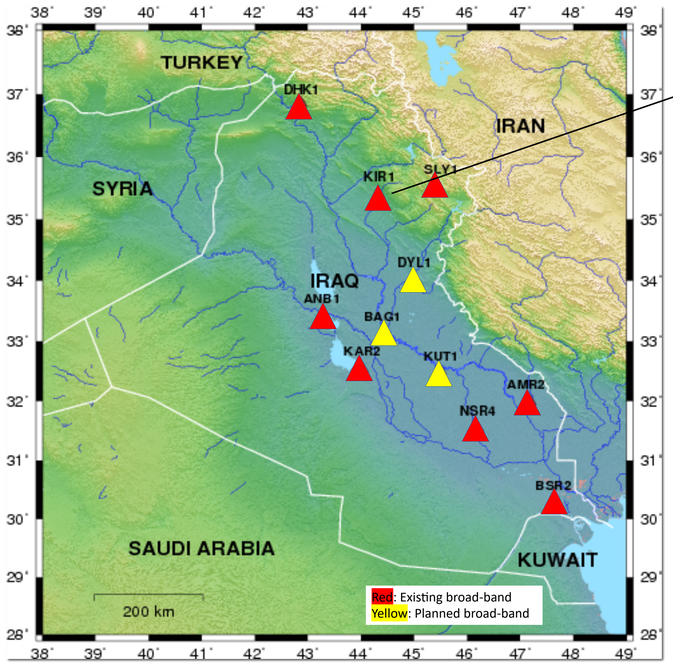
In early 2005, LLNL began assisting seismic monitoring in Iraq through a subcontract with University Arkansas at Little Rock (UALR). At that time, LLNL and UALR purchased three CMG3ESP DM24 broad-band seismic stations (MSL, BHD and DHK) and donated them to the Iraq Seismic Network (ISN) in Baghdad. Recording was intermittent and data was noisy reflecting difficult conditions in Iraq. A peer-reviewed publication on crustal thickness was published following this deployment (Gok et al., 2008).

In 2012, LLNL sponsored a training workshop for ISN personnel in Amman, Jordan. This was followed by a 2014 workshop in Erbil, Iraq to introduce planning for a Probabilistic Seismic Hazard Assessment (PSHA) study to various participants from Iraqi universities and other research organizations.

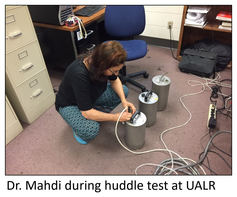


An earthquake near the Iran-Iraq border clearly shows the effect of sedimentary layer in BSR station.





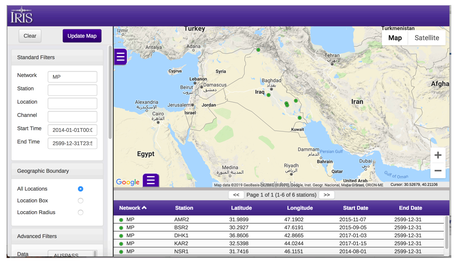
Dr. Abdulnaby during Kirkuk station installation



Dr. Mahdi during huddle test at UALR

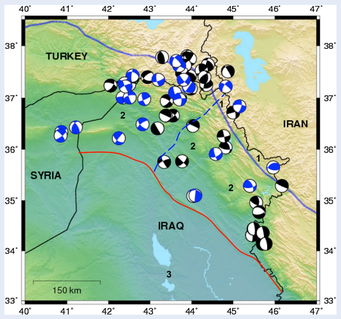
Training during one of the PSHA hands-on workshops at UALR

Dr. Al-Shukri training Dr. Abdulnaby on Quanterra operations

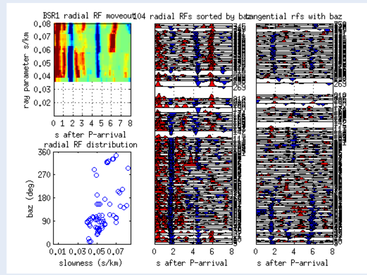


- Current broad-band network of Iraq consists of 8 (CMG3ESP) stations. 3 more will be installed in 2019/2020.
- Newly developed seismic network in Iraq is open through IRIS with "MP" network code. Data availability and individual station performance are areas for future improvement.
- UALR and LLNL provide ongoing support for seismic equipment maintenance, operations, and Iraq network troubleshooting.
- 5 training workshops conducted to date in three locations (Amman, Erbil and UALR).
- 4 graduate students and 2 faculty members in Iraq are supported by this project.

DATA PROVIDED BY MP NETWORK USED IN UNDERSTANDING STRUCTRE AND TECTONICS IN IRAQ



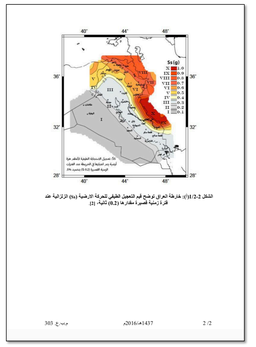
The figure shows focal mechanism solutions for 65 earthquakes in northern Iraq. Black beach-balls are from Abdulnaby et al. (2014), while blue beach balls from Abdulnaby et al. (2013). The solid blue curvy line is the Bitlis–Zagros suture line. The solid red curvy lines represent the tectonic boundary between different tectonic sub-regions. 1-Thrust zone, 2-Foreland fold belt, and 3-Arabian platform. Broken blue curvy line represents the Greater Zab Fault.



Receiver functions example from BSR1 provides information about the crustal thickness (Moho) underneath the station using teleseismic data. Crust is thick due to thick sedimentary layer in Mesopotamia.

NEW SEISMIC PROVISIONS OF NATIONAL BUILDING CODES

الباب الثاني
المعايير التصميمية للزلازل
SEISMIC DESIGN CRITERIA



With support from LLNL, Iraq established new seismic provisions in the national building code in 2016. The second page shows PSHA with a 2% chance of exceedance in 50 years on Site Class B in terms of peak ground acceleration (PGA).

In 2014, LLNL initiated the first national PSHA study in Iraq, in partnership with UALR and Iraqi universities and research organizations. The project goal was to inform new seismic provisions of the national building code to refer to seismic loading in terms of spectral accelerations. Before this effort, results were: a) more than 15 years outdated, b) PGA-based only, and c) at a probability level of 10% chance of exceedance in 50 years, not the 2% that the building code requires.

The PSHA study compiled all available data on local seismicity, tectonics, and ground motion attenuation characteristics of the region and built a flexible framework to enable a contemporary probabilistic seismic hazard assessment to be carried out with the engagement of local scientists. The PSHA framework was used as a blueprint for ongoing training in the form of weekly teleconference meetings, and ultimately published by Onur et al., 2016. This collaboration and resulting publication provided the seismic hazard maps used to produce the first update to the seismic provisions of Iraq's national building code since 1997.

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