The University of Oxford Department of Earth Sciences

EARTHSCIENCES

UNIVERSITY OF OXFORD

Historical and archaeological contributions to earthquake studies in continental Asia

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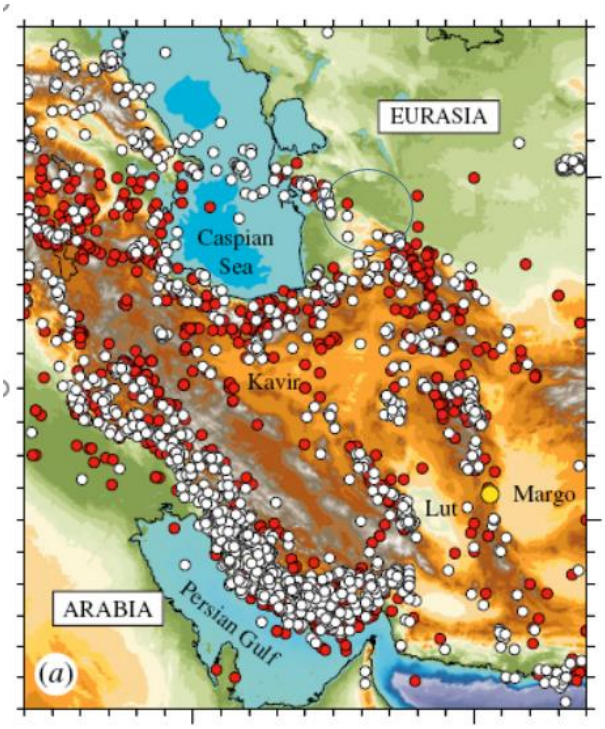
Overview

Earthquake hazard is a pressing global challenge, with populations in continental Asia being particularly vulnerable due to a combination of widespread active faulting and rapid urban growth. Populations and infrastructure are concentrated within narrow regions between arid desert basins and high mountains, in regions at risk from earthquakes.

Because the recurrence interval between destructive earthquakes in any one place can be hundreds, or even thousands of years, the modelling of present-day risk depends on knowledge of past earthquakes extracted from palaeoseismic investigation and from the analysis of historical and archaeological data. The small number of data points, though valuable, limits the completeness of archives from palaeoseismic data. Historical and archaeological data offer widespread constraint, and yet their interpretation is difficult, and relies on painstaking analysis of archive material.

This project combines a supervisory team who specialise in both palaeoseismology, and in historical and archaeological interpretation, through which we will provide new insight into the historical occurrence of major earthquakes within central Asia. We also bring expertise in the use of machine learning techniques in the earth sciences, and will seek to apply these techniques for automatic detection of references ot earthquakes within the vast archive of digitised historical documents.



Instrumentally-recorded (white) and historical (red) earthquakes in Iran > magnitude 5.5 (Jackson 2007). The two datasets are complementary, but still contain gaps where further historical analysis is required, such as in the blue ellipse east of the Caspian Sea. Individual large historic earthquakes are also worthy of specific combined historical and geological investigation.

Methodology

This project calls for a student with aptitude in computation, historical analysis, and in natural hazards. It is suitable for a student with training in history/archaeology with a strong aptitude in physical science, or an earth scientist with interest in the application of historical and archaeological data to the global challenge of earthquake hazards

Timeline

Year 1: In the first year we will develop core skills in geomorphic and archaeological mapping from remote sensing. We will also begin to develop background knowledge of active tectonics in continental regions, as well as indepth knowledge of the history of the central Asia region. We will select a primarily lab-based introduction project to build skills in scientific writing and publication. We anticipate the first field work in the summer (~9 months into the project).

Years 2 and 3: In year 2 we will begin to apply machine learning techniques to historical sources, likely starting with Russian language sources in the first instance. Throughout years two and three we will develop interpretations of historical earthquake activity in specific regions, potentially including northern Iran, Uzbekistan, and the Caucasus. Archive and computational work will be combined with palaeoseismic / archaeoseismic field investigations.

Year 4: Data integration, thesis completion, papers for international journals/conference presentation.

Ruptures from an unknown large Medieval earthquake in Turkmenistan, within the seismic gap (blue ellipse) in the map above. Archaeological, historical, and geological investigation data can contribute to the identification and characterisation of earthquakes such as this (Dodds et al., in revision)

Training & Skills

The student would receive training in:

(a) Analysis of historical and archaeological data and the development of machine learning techniques to recognise natural hazards as recorded in historical and archaeological databases

(b) Field methods relating to the project (i.e. tectonic geomorphology, field surveying using drones, palaeoseismic trenching, sampling for a range of Quaternary dating techniques.

(c) Analysis of satellite imagery and digital topographic models to map and measure earthquake displacements. Construction of digital topographic datasets from stereo satellite imagery and from aerial photographs collected by drone survey.

(d) The student would interact with the wider 'COMET' community of students and researchers, enabling wider training and sharing of knowledge.

References & Further Reading

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Further Information

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