BRITISH SEISMICITY AND SEISMIC HAZARD

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SUMMARY

A comprehensive re-assessment of British seismicity has been undertaken as a foundation for a modern evaluation of seismic hazard to industrial facilities in Great Britain. Emphasis has been placed on making the maximum use of all data sources, whether historical, geological or instrumental, so as to achieve a coherent synthesis of all information on British earthquakes. This approach, coupled with an insistence on a return to primary data sources wherever possible, provides important insight into the origins of British seismicity.

INTRODUCTION

The assessment of British seismicity and seismic hazard until now has been heavily reliant on the Davison history of British earthquakes published in 1924 (ref.1). At that time the understanding of the causes of seismic activity was primitive and the future importance of historical data for the estimation of engineering seismic hazard was not appreciated. Furthermore the approach adopted by Davison to collect and interpret information on British events anomalously reflected the author's own particular bias at the expense of objectivity and accuracy.

If Britain were a region of high seismicity, then the supply of instrumental seismological data in itself might be expected to provide much of the necessary knowledge for seismic hazard analysis. However, Britain is not such a region, and the maximum use of the historical archives has to be made, and furthermore a methodology for processing the historical data has to be devised, so that a proper quantitative foundation for hazard analysis can be laid.

The way in which historical material has been gathered and processed, and correlated with twentieth century instrumental data to form such a foundation, is described fully in a two volume Principia report (ref.2), an outline of which is sketched in this brief communication.

THE BRITISH EARTHQUAKE ARCHIVE

The relatively high population density and long period of literacy in Great Britain is a compensation to the earthquake engineer for its

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intraplate environment: large earthquakes may be uncommon, but those that do occur are often well documented.

The quality and quantity of documentation varies of course from region to region and from one historical period to another. One very early historical account of a British tremor appeared in the seventh century, but it was not for several centuries after this that regular reports of earthquakes were written. The ancient chronicles provide a valuable source of information on these early events, being gradually superceded with the spread of learning outside monastery walls, by personal diaries and journals and later by printed newspapers.

These sources of data have been scanned for evidence of past tremors, and the cumulative volume of information has been assembled into the British Earthquake Archive. This archive, which contains nearly ten thousand sheets of primary data on British events, constitutes a valuable and essential resource for the evaluation of local seismicity.

THE USE OF HISTORICAL INFORMATION

Because of the inhomogeneity of the historical information, considerable care has to be taken over the interpretation and analysis of it. Thus the pre-1800 record, whilst providing some basic information on the epicentres and peak intensities of events, is generally too sparcely detailed to allow for the drawing of isoseismal maps. In contrast, the depth of coverage of events since 1800 is usually sufficient to enable such maps to be drawn even for relatively minor events. This change in circumstances is mainly attributable to the growth in the number of local newspapers, which before the advent of the electronic mass media, furnished often elaborate accounts of tremors of interest to their readership.

Thus for the Hereford earthquake of 6 October 1863, more than thirty local newspaper clippings were found describing this important event. This information, supplementary to accounts found in journals and memoirs, has enabled a new intensity and isoseismal map for the event to be drawn (fig. 1,2).

Similar maps have been produced for all the significant British events of the nineteenth and twentieth centuries to form a uniformly processed file of intensity data.

MAGNITUDE ASSIGNMENT FOR HISTORICAL EVENTS

Of all the earthquakes that have ever occurred in Britain, only a few have been instrumentally recorded. Thus the task of assigning magnitude values to historical events in Britain is not a trivial one, although manifestly important. The resolution of this problem is the development of a correlation formula linking magnitude with the felt area within a given isoseismal. From such a formula, an old event can be calibrated in magnitude via its felt area even where its epicentre may be offshore or in an unpopulated area and its epicentral intensity unknown for one of these or other reasons.

The construction of such a formula requires that for at least some significant British events, both magnitude and felt area are known. Given the comparative rarity of such events, it is clearly necessary that the time span of these events must cover most of the period of instrumental observation.

Fortunately, instrumental surface wave magnitudes can be assigned to a sufficient number of British events of the twentieth century for this construction to be possible, the earliest event being the Doncaster tremor of 23 April 1905. The resulting correlation formulae are

$$M_s = -0.356 + \log A_{III}$$

$$\text{and} \quad M_s = 0.91 + 0.818 \log A_{IV}$$

where A_{III} and A_{IV} are the areas within isoseismal lines III and IV.

A test of the value of these formulae is to compute M_S from each formula, for every event where A_{III} and A_{IV} are reasonably well known, and to check that the M_S values obtained are similar. In fact in every case the difference is no more than about 0.1, thus vindicating the application of these formulae to historical events, and allowing magnitude-frequency statistics to be analyzed.

Such an analysis has been undertaken, and the calculations for Great Britain as a whole indicate a high 'b' value of 1.28, which is confirmation of the relative infrequency of major events. Such events are even less frequent in Scotland than in the rest of Britain; a fact which is confirmed in a somewhat higher 'b' value. This statistic, coupled with the abundance of swarm activity north of the Southern Uplands Fault suggests a different mechanism for earthquake generation in this region, possibly one related to post-glacial isostatic uplift.

REGIONAL VARIATIONS IN SEISMICITY

The difference in seismicity characteristics North and South of the Southern Uplands Fault is only one of many regional variations in seismicity that have been identified in this study, and which entirely refute the assumption of uniform seismicity hitherto often adopted faute de mieux. Such variations encourage the generation of specific tectonic models of crustal movements in Britain to explain these relative patterns of seismicity.

This work, which is currently in progress, will contribute greatly to the understanding of the origins and causes of British earthquakes and consequently to the computation of seismic hazard at different industrial sites around the country.

FIGURE 1

INTENSITY MAP

HEREFORD 6 OCT 1863

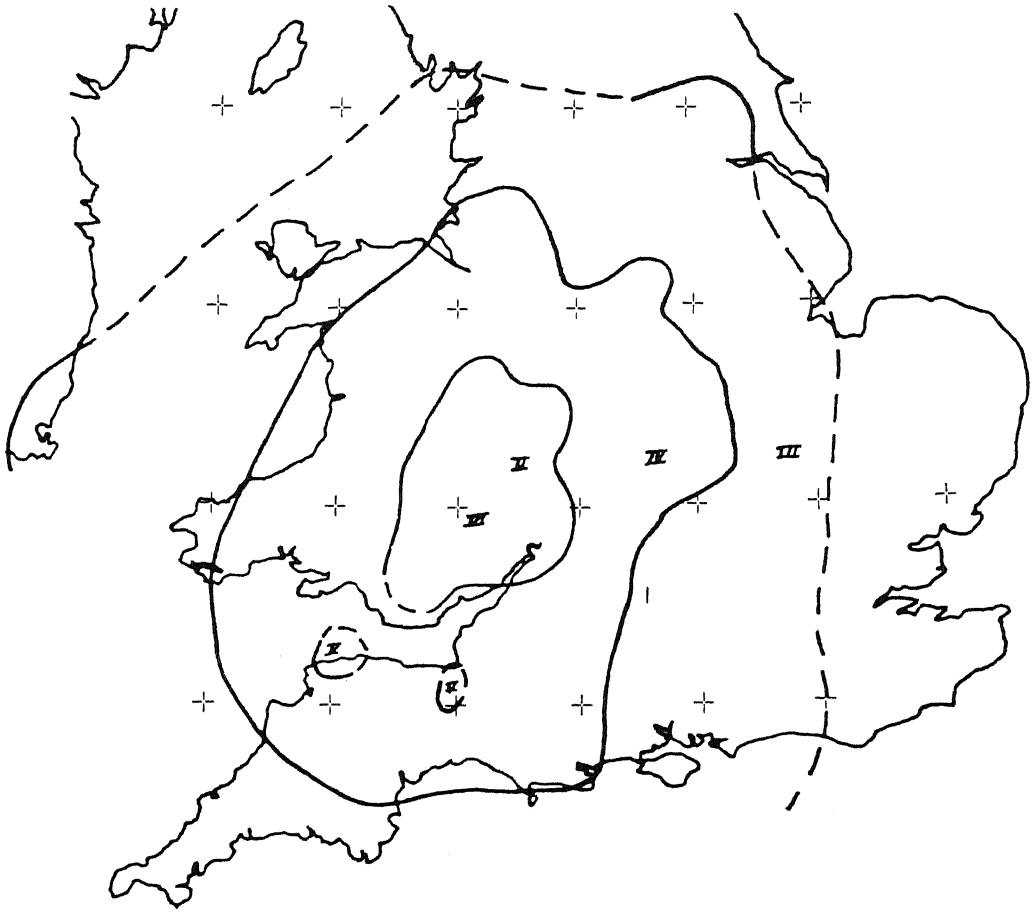

FIGURE 2

ISOSEISMAL MAP

HEREFORD 6 OCT 1863

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