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"EARTHQUAKE LOADING ON THE NORWEGIAN CONTINENTAL SHELF"

ELOCS

THE HISTORICAL SEISMICITY OF THE NORWEGIAN CONTINENTAL SHELF

by R. Muir Wood and G. Woo

ELOCS Report 2-1
December 1987

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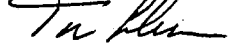

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

SUMMARY

Following lengthy research work in libraries throughout Scandinavia and Britain, a new archive of primary data on western Scandinavian earthquakes has been assembled. This data base provides the foundation for new lists of western Scandinavian earthquakes.

Several hitherto unknown earthquakes have been found in the course of this study, most importantly a large event offshore Møre on 1799/4/19. Through the discovery of many new accounts of felt effects, compared with previous catalogues, significant improvements have been made in the location and size of some of the most important historical events.

The most fruitful period for additional research has been the interval from the publication of Scandinavian newspapers in the mid-eighteenth century to the start of institutional compilation of macroseismic data in 1887. From this period, two large and widely felt nearshore events have been studied in great detail: the Kattegat earthquake of 1759/12/22, and the Nordland earthquake of 1819/8/31. The earlier of these has been found to be of similar size to the Oslofjord earthquake of 1904/10/23. The latter event is notable for being the largest nearshore event in northern Europe from the past two centuries, and for generating the highest epicentral intensity level (VIII) observed in Scandinavia.

The information from this archive has been interpreted systematically in terms of intensity, and events of all periods have been mapped according to a standard procedure. Through a correlation between felt area and surface wave magnitude, developed from 20th century data, magnitude assignments have been made for those historical events with an estimable felt area. For this correlation, use has been made of

instrumental magnitude recalculations undertaken recently by Ambraseys.

The completeness of the historical record has been investigated both by means of historiography and statistics. Knowledge of the breadth of the historical record at different times allows geographical windows to be defined with accompanying magnitude thresholds of observation. These windows are consistent with the results of Stepp analysis of the magnitude-frequency statistics of the regional earthquake catalogue.

1. THE HISTORY OF EARTHQUAKE REPORTING IN SCANDINAVIA

1.1 Introduction

A decade ago information on Scandinavian historical seismicity was of little more than curiosity value. Today the geographical and temporal distribution of past earthquakes provides the most important component of an understanding of earthquake hazard that can hope to mitigate the potential for future damage to offshore installations. The newfound significance of historical earthquakes demands that they be re-researched and analyzed in a form that allows them to be used as a rigorous scientific data base.

This report is the product of research undertaken into the historical seismicity of Scandinavia since 1982. Work began as part of a study funded by UK Department of Energy concentrating on the British sector of the North Sea (Woo and Muir Wood, 1986), and has been continued through funding obtained as part of individual North Sea Norwegian sector site hazard studies undertaken for Norsk Hydro and Statoil. An expansion of research into offshore Northern Norway and a final phase of data collection and data analysis was undertaken within the ELOCS project.

In the early part of the research primary archive was shared with Professor Nicholas Ambraseys of Imperial College, London, and Ambraseys published his own catalogue for the region in 1985 (Ambraseys, 1985). While this catalogue is a significant improvement on what has gone before, it was achieved without much of the primary data that has subsequently been acquired in this study through Scandinavian library research in particular into newspapers. The new primary data has allowed a number of refinements to be made to the historical data base, and has even identified some previously unknown earthquakes.

Some of the most significant improvements (see Fig. 1.1) are for the epicenter of the largest near-shore earthquake, that of 1819/8/31, that has a coastal location 100 km to the west of Ambraseys' preferred epicenter, and the size of the 1759/12/22 Kattegat earthquake, which had far larger isoseismal areas than were mapped by Ambraseys, and hence a higher magnitude. Other events which show significant changes are those of 1865/5/7 which had an epicenter in inner Rogaland rather than in the North Sea, the 1841/4/3 earthquake which had an epicenter onland in Jutland rather than in the Skagerrak, a "new" major offshore Møre earthquake on 1799/4/19 and some earthquakes in January and February 1757 which Ambraseys places in Tønsberg, outer Oslo Fjord, Norway, but that in fact occurred 400 km to the south in Holstein, in what is now southern Jutland, Denmark.

The first and most laborious component of the project has involved a search for primary documentation. For Norway (Kolderup, 1913) and Sweden (Kjellen, 1910) there has been no significant research initiative on historical seismicity since the first decade of this century. The standard historical catalogue for Norway is itself largely based on work undertaken 150 years ago (for the pre-1834 record, Keilhau, 1835, 1836) and a century ago for the record from 1834-1888 (Thomassen, 1888). In Denmark the earlier researches are of a higher standard than those in Norway (Johnstrup, 1870), but much remains to be achieved in the understanding of the complete picture of historical seismicity in that country.

Having collected all the references known to the earlier cataloguers, it is necessary to begin a search for new material. This has been organized to follow two distinct paths. First for earthquakes of known date, there has been a search for new contemporary sources of information in newspapers, diaries, etc. This work has involved many hours of effort tracking down obscure journals, and searching through

newspapers in libraries in Bergen, Trondheim, Bodø, Oslo, Stavanger, Stockholm, Copenhagen, London and Cambridge.

Second, some rich information sources, such as travellers' accounts and early newspapers, have been scanned for details of previously unknown earthquakes. There can be no simple program for such research as new information and new earthquakes emerge from the exploration of data sources that earlier cataloguers had not thought to use. The information reported here provides the (successful) tip of an iceberg of what has been studied. Many of the most important new findings in this study emerged from this wide-ranging search. For the large 1819/8/31 earthquake such searching provided some vital new documentation - including an account by an English traveller who passed through northern Norway the following spring (Brooke, 1823), a detailed description of the effects of the earthquake in an original local history (Heltzen, 1831), and a recent collection of oral histories of the earthquake published in a local history yearbook in the parish of Lurøy (Aavik, 1985).

The area of study has principally been the Norwegian continental shelf, although as tectonic and seismological provinces do not follow either national frontiers or land-sea boundaries, the region of interest includes the whole of western Scandinavia. This comprises the whole of Norway along with western Sweden and much of northern Denmark. Scotland and the Shetlands afford an eastern edge of the area to the south, but to the north, on the margins of the Norwegian Sea, there is no effective eastern boundary, which instead simply represents the limits of the onland perception of offshore earthquakes.

The history of the study of earthquakes in this region is indivisible from the history of the earthquakes themselves, because the most important initiatives have often been triggered by major earthquakes. Therefore section 1 provides a review both of earthquakes and earthquake documentation. Within this survey dates and times of earlier