

Engineering Geology Case Histories

Number 8

Engineering Seismology: The Works of Man

Edited by

WM. MANSFIELD ADAMS



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of
The Geological Society of America

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This Number of the
Case Histories is Dedicated
to the Memory of
Parker D. Trask,
Editor of Three Previous Case Histories

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FOREWORD

The geologist and the geophysicist have always been aware of the environment as it is the subject of their continual study. The objective of such study is frequently to actively modify, not just passively observe, the environment. Most spectacular of the interactions of man with his geological environment is underground nuclear explosions. For the engineering seismologist (or seismological engineer) underground nuclear explosions present a new tool - for excavating harbors or canals; a new problem - of predicting and measuring high intensity seismic vibrations; and even a new environment - by the creation of novel minerals and isotopes. Man can at last probe the interior of the Earth with vibrations from a controlled source of known origin time and energy level. An understanding, or at least an appreciation, of underground nuclear explosions is requisite for the engineering seismologist today. Therefore, the first two papers in this number are studies of the seismic energy released by underground explosions. The first study covers the free-field zone, before interface effects, within tens of feet of chemical explosions being used to model some of the seismic features of an underground nuclear explosion: the second study covers the 300-meter to 20-kilometer range.

Man is aware not only of the significance of thresholds in the environment, such as critical mass, but also of the sensitivity of the environment to changes in boundary conditions.

One such boundary condition is for a point--injection or withdrawal of fluid from a well. The well operation has occasionally been associated geographically with seismic activity. Most pertinent is to ascertain if the association is causal, not just coincidental. For understanding, and ultimately prediction and control, study of possible causal mechanisms must be explored. Three papers in this number are devoted to the earthquakes which occurred in the vicinity of the well being used for disposal of effluents from the Rocky Mountain Arsenal. One paper compares the effects of waterflooding an oil field.

Another such boundary condition is for a line - the damming of rivers. Changing such a relatively minor boundary has permitted the impoundment of more mass than could have been moved otherwise, even with nuclear explosives. Indeed, the weight of the water impounded by such a dam becomes comparable to the level of stress in the crust of the Earth. These induced stresses have sometimes exceeded the strength of the crust and shocks have resulted. One paper in this number is devoted to local earthquakes caused by the filling of reservoirs.

Not only has man been actively modifying his environment, but also he has been pressed to live in areas having high exposure to natural hazards, such as earthquakes and tsunamis (sometimes erroneously called tidal waves). One paper in this group is devoted to analyzing and estimating the additional risk entailed by construction in a coastal environment subject to tsunami inundation.

Hopefully the engineering seismologist will benefit notably from the data, methods, or results in these case histories. The reader interested in additional details should contact the author directly, as I have taken the liberty of condensing and revising the papers.

Reports which might be appropriate for consideration for inclusion in a future Case Histories Number on Engineering Seismology should be brought to the attention of the Chairman of the Topical Committee on Engineering Seismology, currently Dean S. Carder.

Wm. Mansfield Adams
Editor of this Number
February 1970

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PREFACE

This report on Engineering Seismology Case Histories is a supplement to a series of similar reports on Engineering Geology which first appeared in May 1957 under the editorship of Parker D. Trask. The purpose of this and other reports which are to follow is to present the seismological aspects of projects having general interest to the civil engineer and the engineering geologist. Topics covered in this first issue are in two categories: ground effects from nuclear and other explosions, and association of local earthquakes with the works of man such as reservoir loading and downhole injection of fluids. Reports in the latter category are in large part drawn from published material appearing in journals of limited circulation; however considering current interest in this topic, inclusion of pioneering case histories and a summary of current work in one volume seems appropriate. The same argument applies to pioneering efforts in predicting ground effects from large explosions. Work on these and other topics of interest to the engineering geologist are scheduled for inclusion in a subsequent issue of Engineering Seismology Case Histories.

Dean S. Carder, Chairman
Topical Committee on Engineering Seismology

