Earthquakes Induced by Underground Nuclear Explosions
Environmental and Ecological Problems

Edited by
Rodolfo Console
Istituto Nazionale di Geofisica
Via di Vigna Murata 605
I-00143 Roma, Italy

Alexei Nikolaev
Institute of Experimental Geophysics, RAS
51 Nikoloyamskaya St.
Moscow 109004, Russia

Springer
Published in cooperation with NATO Scientific Affairs Division
# TABLE OF CONTENTS

## INTRODUCTION

- UNDERGROUND NUCLEAR EXPLOSIONS AND ENVIRONMENTAL PROBLEMS
  - R. Console

- INDUCING OF EARTHQUAKES BY UNDERGROUND NUCLEAR EXPLOSIONS
  - A. Nikolaev

## INDUCING OF EARTHQUAKES BY UNDERGROUND NUCLEAR EXPLOSIONS AND BY REMOTE EARTHQUAKES

- EARTHQUAKE ACTIVITY ASSOCIATED WITH UNDERGROUND NUCLEAR EXPLOSIONS
  - P.G. Richards and G. Ekström

- AFTERSHOCKS OF UNDERGROUND NUCLEAR EXPLOSION
  - V. Adushkin and A. Spivak

- STATISTICAL ANALYSIS OF EFFECT OF NOVAYA ZEMLYA UNDERGROUND NUCLEAR EXPLOSIONS ON DISTANT EARTHQUAKES
  - J.A. Borisyuk, A.M. Novikov, A.V. Seryi

- TRIGGERING OF EARTHQUAKES BY EARTHQUAKES
  - A. Nikolaev, L. Ruff, L. Zimakov

- INDUCING OF WEAK SEISMICITY BY DISTANT INDUSTRIAL EXPLOSIONS: EVIDENCE FROM STATISTICAL CHARACTERISTICS OF SEISMIC ENERGY RELEASE
  - M.V. Nevskiy, O.Yu. Riznichenko, A.M. Artamonov
ON TRIGGERING LARGE EARTHQUAKES BY UNDERGROUND NUCLEAR EXPLOSIONS - STATISTICAL METHODS OF DETECTION, POSSIBLE MECHANISM AND APPLICATION
A. Prozorov 103

INDUCING STRESS WAVES BY UNDERGROUND NUCLEAR EXPLOSIONS
V.A. Anikolenko and A.V. Nikolaev 123

THE INFLUENCE OF UNDERGROUND NUCLEAR EXPLOSIONS UPON FINE STRUCTURE OF SEISMICITY IN KIZEL COAL MINE FIELD
A. Malovishko 133

ON MODELLING OF THE EARTHQUAKES' DYNAMICS IN GEODYNAMICAL SYSTEMS IN THE CONTEXT OF GEOLOGICAL MEDIUM SYSTEM ORGANISATION
I. Volodin, I. Pryanikov, N. Flavitsky 143

EFFECT OF UNDERGROUND NUCLEAR EXPLOSIONS ON SEISMIC ACTIVITY IN SURROUNDING REGIONS
O.K. Kedrov and G.M. Steblov 149

POSSIBLE MECHANISM OF INDUCING EARTHQUAKES BY UNDERGROUND NUCLEAR EXPLOSIONS
S. Balassanian 163

INDUCED SEISMICITY RELATED PROBLEMS

THE TRIGGERING OF AFTERSHOCKS: PART 1: A SEARCH FOR TIDAL PERIODICITIES IN THE 1989 LOMA PRIETA (CALIFORNIA) AFTERSHOCK SEQUENCE
L. Mansinha and Kamal 177

THE TRIGGERING OF AFTERSHOCKS: PART 2: NORMAL MODE PERIODICITIES IN THE 1989 LOMA PRIETA (CALIFORNIA) AFTERSHOCK SEQUENCE
Kamal and L. Mansinha 187

EARTHQUAKE INDUCED SEISMICITY: EVIDENCE FROM THE MS7.4 LANDERS, EARTHQUAKE AND THE GEYSERS FIELD, CALIFORNIA
J. Gomberg 201
RESPONSE OF SEISMOACTIVE MEDIUM TO NUCLEAR EXPLOSIONS
N.T. Tarasov and N.V. Tarasova 215

EARTHQUAKE TRIGGERING: A REVIEW OF EVIDENCE FROM THE 1992 LANDERS, CALIFORNIA, SEQUENCE
S.E. Hough 225

DETECTION OF IONOSPHERIC PERTURBATIONS FOLLOWING AN EARTHQUAKE WITH THE GLOBAL POSITIONING SYSTEM: IMPLICATIONS FOR NUCLEAR TESTS DISCRIMINATION
E. Calais and J.B. Minster 235

ON THE EARTHQUAKE TRIGGERING BY THE EARTH'S TIDE AND UNDERGROUND NUCLEAR EXPLOSIONS
V. Nikolaev 255

IONOSPHERIC RESPONSE TO NATURAL AND MAN-MADE IMPACTS
O.A. Prokhotelov, M. Parrot, E.N. Fedorov, V.A. Pilipenko, V.V. Surkov and V.A. Gladychev 267

NEAR REAL TIME ESTIMATION OF SEISMIC EVENT Magnitude and Moment Via P and LG PHASES
C.D. Mendi and E.S. Husebye 281

ON MS:MB STATISTICS FOR EARTHQUAKES AND EXPLOSIONS AND THEIR RELATION TO SOME SOURCE PARAMETERS
A. Kaverina and A. Prozorov 301

LIBRATION POINTS OF TRIAXIAL ROTATING ELLIPSOID AND THEIR APPLICATION IN GEODYNAMICS
A. Bekov 319

ON ORIGINATION OF LONGLASTING ELECTRIC ANOMALIES ABOVE UNDERGROUND EXPLOSION FOCI
M.Ya. Balbachan and M.B. Gokhberg 323

GEOMETRY OF SEISMIC MOMENT TENSOR REPRESENTATIONS FOR UNDERGROUND NUCLEAR EXPLOSIONS
Z. Wu 333
INDUCED SEISMICITY AND ENVIRONMENTAL PROBLEMS

CORRELATION OF FILLING HISTORY WITH SEISMICITY NEAR ARTIFICIAL WATER RESERVOIRS
B.K. Rastogi 343

REMOTE TRIGGERING OF LARGE SEISMIC EVENTS IN MINES: EVIDENCE BASED ON THE SPATIAL AND TEMPORAL MIGRATION OF MICROSEISMIC EVENTS ALONG INCREASING STRESS GRADIENTS
T.I. Urbancic and C.I. Trifu 353

RESERVOIR INDUCED SEISMICITY: TWENTY YEARS OF RESEARCH ASSOCIATED WITH WATER STORAGE IMPOUNDMENT AND OPERATIONS
T. Vladut 375

A POSSIBILITY OF SEISMIC ACTIVITY INDUCTION BY TECHNOCENIC PROCESSES IN KARA BOGAZ-GOL GULF
B. Karryev 383

ROLE OF SEISMOGENIC SUBHORIZONTAL EARTH CRUST'S ZONES IN INDUCING OF EARTHQUAKES
V. Barabanov 391

THE FRACTURE MECHANICS OF INDUCED SEISMIC EVENTS: PROBLEMS AND ADVANCES
P. Knoll and G. Kowalle 403

KINETIC APPROACH TO ROCK FRACTURE PROCESS AND MONITORING OF INDUCED SEISMICITY
V.A. Anikolenko 413

CONTRIBUTIONS TO UNDERSTANDING MAN-MADE SEISMICITY. ENVIRONMENTAL CONCEPTS: DESIRES AND REALITIES
T. Vladut 421

EXAMPLES OF RELATIONSHIP OF SPECIFIC FEATURES OF GEOLOGICAL STRUCTURE VS. MAN-MADE SHOCKS OCCURRENCE
D. Prochazkova 429