

Political Seismology or Seismological Politics: Natural Resources Defense Council–USSR Experiments in Underground Nuclear Test Verification

by Anna Amramina

INTRODUCTION

In the 1980s, the Institute of Physics of the Earth (IPE) in Moscow was challenged by the Soviet Academy of Sciences with an ambitious task to become the Soviet representative in an unprecedented joint project with the United States of America in a defense-sensitive area. In 1986–1988, a series of experiments was held on two major nuclear test sites, in Nevada in the United States and Semipalatinsk in Kazakhstan, to prove the scientific possibility of verifying the exact location and yield of underground nuclear explosions. The story hardly sounds sensational; however, there are reasons to believe that it stands out in the chain of events that led to the current Comprehensive Nuclear-Test-Ban Treaty (CTBT). This paper marks the twenty-fifth anniversary of the exceptional example of seismologists acting on the forefront of global politics.

The majority of available materials on this project exist only as technical reports, protocols, and presentations. The course of events was covered extensively from the U.S. point of view by an American historian of science, K.-H. Barth. His paper, as well as this article, argues that there are situations in which the critical mass of scientific knowledge can overpower the political pressure on the international scale (Barth, 2006); moreover, in times of a global threat, scientists can accumulate enough influence to become a strategic force for change. This paper attempts a glimpse of the international seismological research in nuclear arms control at the end of the Cold War through the lens of joint Soviet–American experiments in underground nuclear testing verifications from the historical rather than the geophysical point of view, and it is aimed at honoring the experiments as one of the independent research initiatives put forward by scientists that influenced the decisions of top government officials.

POLITICAL BACKGROUND

The initiative was preceded by nearly 20 years of deadlock in negotiations between the Union of the Soviet Socialist Repub-

lics (USSR) and the United States about nuclear test bans, in which the issue of verification became a stumbling block. There had been suspicions and accusations on technical grounds concerning verification difficulties from both sides since the Geneva Conference of Experts of 1958. One of the main issues in this argument concerned the intentional concealment of underground nuclear tests or their yield; and, until the issue was resolved scientifically, there seemed to be no end to this fight. The last attempt at seeking understanding in this matter was the signing of the 1974 Treaty on the Limitation of Underground Nuclear Weapon Tests, also known as the Threshold Test Ban Treaty (TTBT). It established a nuclear threshold by prohibiting tests with a yield exceeding 150 kt, but it did not put a final stop to either underground tests or the atmosphere of mistrust between two major acting forces in Western politics, resources, and warfare. In the following decade the U.S. administration was reluctant to become proactive in this matter, and Soviet actions toward further test bans were self-serving (Morrison, 1987).

The negotiations came to a halt with the deployment of Soviet troops in Afghanistan in 1979. In 1982 President Reagan, following the policy of his predecessor, Jimmy Carter, declined to resume talks on a comprehensive test ban under the pretext of the demand for further nuclear testing, absence of reliable methods of verification, and continuous violations of the 150 kt threshold by the Soviet Union.

Utter distrust between the countries sometimes resulted in curious incidents. American seismologist J. Evernden, who later enrolled on the American team of experts in the joint experiments, sent a letter to the journal *Science*, rebutting false accusations toward the USSR of violating the 150 kt TTBT (Evernden, 1985). At that time, Soviet censors were deleting anything about the Soviet nuclear testing program from the released copies of *Science*. Thus, when the issue reached the USSR, the letter was censored out, even though it spoke in favor of the USSR.

TECHNICAL STUMBLING BLOCKS

The problem of unequivocal verification of underground nuclear tests was a strong and convenient argument for those opposed to banning nuclear testing. Seismic methods were used already by both sides at that time for TTBT verification. The

Interview with Dr. Jack E. Evernden by Kai-Henrik Barth in Golden, Colorado in June 16, 1998, Niels Bohr Library & Archives, American Institute of Physics, College Park, Maryland, <http://www.aip.org/history/ohilist/5914.html>.

Seismology 1989 1992 Nuclear Test Ban Verification

Astrid Persson, Marie-Louise Schyberg



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Seismology, 1989-1992 Astrid Persson, Marie-Louise Schyberg, 1994-12 Covers the work of the Swedish data center in the international seismological verification system that monitors underground nuclear explosions and provides data for research on detection location and identification of low magnitude seismic events Maps charts and graphs Seismology 1989-1992 Astrid Persson, Marie-Louise Schyberg, 1993 Monitoring the Comprehensive Nuclear-Test-Ban Treaty: Source Processes and Explosion Yield Estimation Goran Ekstrom, Marvin Denny, John R. Murphy, 2012-12-06 Pure appl geophys by 161 nations Entry of the treaty into force however is still uncertain since it requires ratification by all 44 nations that have some nuclear capability and as of 15 June 2001 only 31 of those nations have done so Although entry of the CTBT into force is still uncertain seismologists and scientists in related fields such as radionuclides have proceeded with new research on issues relevant to monitoring compliance with it Results of much of that research may be used by the International Monitoring System headquartered in Vienna and by several national centers and individual institutions to monitor compliance with the CTBT New issues associated with CTBT monitoring in the 21st century have presented scientists with many new challenges They must be able to effectively monitor compliance by several countries that have not previously been nuclear powers Effective monitoring requires that we be able to detect and locate much smaller nuclear events than ever before and to distinguish them from small earthquakes and other types of explosions We must have those capabilities in regions that are seismically active and geologically complex and where seismic waves might not propagate efficiently *Forensic Seismology and Nuclear Test Bans* Alan Douglas, 2013-03-14 Springing from 50 years experience in forensic seismology research this book charts the development of seismic data analysis **Monitoring the Comprehensive Nuclear-Test-Ban Treaty** H.J. Patton, Brian J. Mitchell, 2001-09-01 Regional seismograms are dominated by the phases Pn Pg Sn and Lg More often Sn and Lg are used to infer the attenuation structure of the lithosphere The seismic phase Sn is a high frequency shear wave typically from 1 to 4 Hz and occasionally higher that travels in the lithospheric mantle above the negative velocity gradient which usually marks the lithosphere asthenosphere boundary Sn has been reported out to distances of 35 e g MOLNAR and OLIVER 1969 HUESTIS et al 1973 Sn arrives as a high frequency wave train lasting tens of seconds and up to 1 to 2 minutes Sn velocities are typically 4 7 km s in stable continental and oceanic lithosphere HUESTIS et al 1973 and as low as 4 3 km s KADINSKY CADE et al 1981 in more tectonically active regions Lg is a complex short period guided wave consisting of high frequency P and S energy which travels primarily in the earth s crust at frequencies typically between 0 5 and 5 Hz It has been modeled as higher mode Love and Rayleigh waves as well as a sequence of multiply reflected post critical S waves trapped in a crustal guide BOUCHON 1982 KENNETT 1986 BOSTOCK and KENNETT 1990 Lg has been observed not to propagate in oceanic or very thin continental crust PRESS and EWING 1952 SEARLE 1975 ZHANG and LAY 1995 *Government Reports Annual Index*, 1994 **Verification** Allan S. Krass, Stockholm International Peace Research

Institute, 2020-11-19 Originally published in 1985 the level of anxiety and suspicion between the USA and the USSR had rarely been higher Many advocates of arms control believed that effective verification would reduce tensions and lessen the risk of war This book analyses the two main issues of verification One is technological what are the present capabilities of various verification techniques and what is their potential The devices and methods currently employed by the two major nuclear powers and by international organizations to monitor the compliance of states with arms control or disarmament treaties are examined The second issue is political how do US and Soviet approaches compare what are the roles of domestic and bureaucratic politics and on what criteria can a workable standard of adequacy be based In short how much is enough Although the study concludes that a number of significant arms control measures can already be adequately verified modern weapons are becoming more mobile and it is becoming easier to conceal them There is a danger that the ability to hide weapons will outstrip the ability to find them Verification cannot promise to detect all violations a workable standard of adequacy in verification must derive from the ability to detect militarily significant violations Silencing the Bomb Lynn R. Sykes, 2017-12-12 In December 2016 the Bulletin of Atomic Scientists moved their iconic Doomsday Clock thirty seconds forward to two and a half minutes to midnight the latest it has been set since 1952 the year of the first United States hydrogen bomb test But a group of scientists geologists engineers and physicists has been fighting to turn back the clock Since the dawn of the Cold War they have advocated a halt to nuclear testing their work culminating in the Comprehensive Test Ban Treaty which still awaits ratification from China Iran North Korea and the United States The backbone of the treaty is every nation's ability to independently monitor the nuclear activity of the others The noted seismologist Lynn R Sykes one of the central figures in the development of the science and technology used in monitoring has dedicated his career to halting nuclear testing In Silencing the Bomb he tells the inside story behind scientists quest for disarmament Called upon time and again to testify before Congress and to inform the public Sykes and his colleagues were for much of the Cold War among the only people on earth able to say with certainty when and where a bomb was tested and how large it was Methods of measuring earthquakes researchers realized could also detect underground nuclear explosions When politicians on both sides of the Iron Curtain attempted to sidestep disarmament or test ban treaties Sykes was able to deploy the nascent science of plate tectonics to reveal the truth Seismologists discoveries helped bring about treaties limiting nuclear testing but it was their activism that played a key role in the effort for peace Full of intrigue international politics and hard science used for the global good Silencing the Bomb is a timely and necessary chronicle of one scientist's efforts to keep the clock from striking midnight *Yearbook of the United Nations, Volume 46 (1992)* United Nations, 2023-08-28 Fully indexed the 1992 edition of the Yearbook is the single most current comprehensive and authoritative reference publication about the work of the United Nations other international organizations and related bodies The book is designed not just for use by diplomats officials and scholars but also by other researchers writers journalists teachers and students The year 1992 was a

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Institute, Canadian Institute for International Peace and Security, 1988 How feasible and how vital is the achievement of a meaningful test limitation treaty This book presents a wide range of authoritative expertise and opinion as an informed contribution to the debate among governmental experts and the informed public Monitoring the Comprehensive Nuclear-Test-Ban Treaty Frode Ringdal, Brian L. N. Kennett, Brian Leslie Norman Kennett, 2001 In September 1996 the United Nations General Assembly adopted the Comprehensive Nuclear Test Ban Treaty CTBT prohibiting nuclear explosions worldwide in all environments The treaty calls for a global verification system including a network of 321 monitoring stations distributed around the globe a data communications network an international data centre IDC and on site inspections to verify compliance This volume contains research papers focusing on seismic event location in the CTBT context The on site inspection protocol of the treaty specifies a search area not to exceed 1000 square km Much of the current research effort is therefore directed towards refining the accuracy of event location by including allowances for three dimensional structure within the Earth The aim is that the true location of each event will lie within the specified source zone regarding postulated location The papers in this volume cover many aspects of seismic event location including the development of algorithms suitable for use with three dimensional models allowances for regional structure use of calibration events and source specific station corrections They provide a broad overview of the current international effort to improve seismic event location accuracy and the editors hope that it will stimulate increased interest and further advances in this important field

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inspections to verify compliance This volume contains research papers focusing on seismic event location in the CTBT context The on site inspection protocol of the treaty specifies a search area not to exceed 1000 square km Much of the current research effort is therefore directed towards refining the accuracy of event location by including allowances for three dimensional structure within the Earth The aim is that the true location of each event will lie within the specified source zone regarding postulated location The papers in this volume cover many aspects of seismic event location including the development of algorithms suitable for use with three dimensional models allowances for regional structure use of calibration events and source specific station corrections They provide a broad overview of the current international effort to improve seismic event location accuracy and the editors hope that it will stimulate increased interest and further advances in this important field

Monitoring the Comprehensive Nuclear-Test-Ban Treaty: Seismic Event Discrimination and Identification William R. Walter, Hans E. Hartse, 2013-04-18 In September 1996 the United Nations General Assembly adopted the Comprehensive Nuclear Test Ban Treaty CTBT prohibiting nuclear explosions worldwide in all environments The treaty calls for a global verification system including a network of 321 monitoring stations distributed around the globe a data communications network an international data center and onsite inspections to verify compliance The problem of identifying small magnitude banned nuclear tests and discriminating between such tests and the background of earthquakes and mining related seismic events is a challenging research problem Because they emphasize CTBT verification research the 12 papers in this special volume primarily addresses regional data recorded by a variety of arrays broadband stations and temporarily deployed stations Nuclear explosions earthquakes mining related explosions mine collapses single charge and ripple fired chemical explosions from Europe Asia North Africa and North America are all studied While the primary emphasis is on short period body wave discriminants and associated source and path corrections research that focuses on long period data recorded at regional and teleseismic distances is also presented Hence these papers demonstrate how event identification research in support of CTBT monitoring has expanded in recent years to include a wide variety of event types data types geographic regions and statistical techniques

Nuclear Weapons Stuart Casey-Maslen, 2021-11-04 A new nuclear arms race is underway between Russia and the United States one that focuses on the technology of delivery of nuclear warheads This book describes how and why this race is happening who still possesses nuclear weapons and what constraints apply to those weapons under international law A global nuclear ban treaty entered into force in January 2021 but the nuclear powers kept distant The last remaining treaty restraining the arsenals of the two nuclear superpowers will expire in less than five years time and the risk is that other States will turn to nuclear arms for their defence further fracturing the non proliferation regime installed after the Cuban missile crisis

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Nuclear-Test-Ban Treaty: Data Processing and Infrasound Zoltan A. Der, Robert H. Shumway, Eugene T.

Herrin, 2002-05-01 On September 10 1996 The United Nations General Assembly adopted the Comprehensive Nuclear Test Ban Treaty CTBT prohibiting nuclear explosions worldwide in all environments The treaty calls for a global verification system including a network of 321 monitoring stations distributed around the globe a data communications network an international data center IDC and on site inspections to verify compliance This volume presents certain recent research results pertaining on methods used to process data recorded by instruments of the International Monitoring System IMS and addressing recording infrasound signals generated by atmospheric explosions Six papers treating data processing provide an important selection of topics expected to contribute to improving our ability to successfully monitor a CTBT Five papers concerning infrasound include descriptions of ways in which that important research area can contribute to CTBT monitoring the automatic processing of infrasound data and site conditions that serve to improve the quality of infrasound data

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