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CTBTO PREPARATORY COMMISSION
preparatory commission for the comprehensive nuclear-test-ban treaty organization

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CTBTO SPECTRUM

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CTBT VERIFICATION: A SYSTEM OF TIES

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) bans all nuclear explosions on Earth.

It opened for signature on 24 September 1996 in New York.

As of October 2010, 182 countries had signed the Treaty and 153 had ratified it. Of the 44 nuclear capable States which must ratify the CTBT for it to enter into force, the so-called Annex 2 countries, 35 have done so to date while nine have yet to ratify: China, the Democratic People's Republic of Korea, Egypt, India, Indonesia, Iran, Israel, Pakistan and the United States. On 3 May 2010, Indonesia stated that it had initiated the CTBT ratification process.

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) consists of the States Signatories and the Provisional Technical Secretariat. The main tasks of the CTBTO are to promote signatures and ratifications and to establish a global verification regime capable of detecting nuclear explosions underground, underwater and in the atmosphere.

The regime must be operational when the Treaty enters into force. It will consist of 337 monitoring facilities supported by an International Data Centre and on-site inspection measures.

COVER IMAGE:
Simulated infrared view of Comet Tempel 1. Photo courtesy of the National Aeronautics and Space Administration (NASA) and the California Institute of Technology. Celestial bodies, such as meteorites, that enter the Earth's atmosphere can be detected by the International Monitoring System's infrasound network.

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EDITORIAL
TIBOR TÓTH
EXECUTIVE SECRETARY

For a brief moment at the end of September, astronomers challenged our sense of cosmic entitlement when a planet that may contain water, the font of life on Earth, hove into the view of powerful telescopes.

It was inevitable that after looking afar our gaze would turn homeward. Regrettably, it's hard to overlook the fact that our own small blue orb in the vastness of space harbours within it the seeds of its own destruction: nuclear weapons left over from a conflict that elapsed two decades ago.

Gliese 581g, a so-called Goldilocks planet, neither too hot nor too cold and 20 light years from Earth, may harbour life no more exciting than duckweed and algae. Yet its discovery is a looking glass; all travellers arriving upon new wonders inevitably view them through the prism of what's familiar – the touchstone of home.

Our view of Earth is occluded by more than 20,000 nuclear weapons that continue to have the potential for our annihilation. It is such an extraordinary anomaly that we'd be hard pressed to explain it to any denizens of Gliese 581g.

Which goes to the nub of the current debate about nuclear weapons – why do we retain them and what security do they offer?

My answer is that they are a dangerous liability. Mutually assured destruction defined the stalemate when two armies bristling with nuclear weapons confronted each other across the plains of the Cold War. The danger of such a war may have receded but as long as nuclear weapons exist, the risk of regional nuclear war or accidental use remains, as does the spectre of terrorists getting their hands on them.

Albeit slowly, we are beginning to acknowledge our liabilities and devise new ways of eliminating nuclear weapons. Such wisdom is gaining increasing support, from grassroots movements to former statesmen to world leaders. Greater efforts to inform an often unsuspecting public that it is sitting on a nuclear powder keg will also yield exponential results.

So far we've avoided World War III: the opportunity now exists to eliminate the weapons it would have been fought with. The forums and legal instruments that will be required to complete the task are in place.

However, we must proceed on the basis of Murphy's Law: that whatever can go wrong will go wrong.

It's pretty clear though where our next steps must take us. In New York in May nearly 190 States Parties of the Nuclear Non-Proliferation Treaty (NPT) spelled these steps out at their five yearly review meeting. Building on the groundswell of opposition to nuclear weapons, they committed themselves to a world free of them.

I cannot claim that all nuclear challenges can be resolved solely through multilateral treaty regimes – but they certainly cannot be resolved without them.

Cheaters will challenge the system and problems will emerge that require innovative responses. Yet treaties are measures of legitimacy, accepted norms for international cooperation.

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is an instrument for nuclear non-proliferation and disarmament whose ratification is the obvious next step to take. It could serve as a regional confidence- and security-building measure in regions such as the Middle East and Asia. It's a practical tool whose time is now.

It provides a firm legal barrier against nuclear testing, thereby curbing the further development of nuclear weapons by nuclear and non-nuclear weapon States alike. It also sets new legal and verification standards for nuclear weapons since it contains the same rights and obligations for everyone.

The articles in this issue of Spectrum are from a diverse range of voices: former U.S. Republican Senator Jake Garn of Utah; Lieutenant General Talat Masood, former Secretary for Defence Production in the Ministry of Defence, Pakistan; Dr Bharath Gopalaswamy, formerly of the Indian Space Research Organization, now at the Stockholm International Peace Research Institute (SIPRI); and Professor Xia Liping of Tongji University in China, all giving support to the CTBT and its verification regime.

A collection of points of view from such a varied landscape sets a new precedent for Spectrum and I sincerely welcome these thoughtful and timely contributions provided by their respective authors.

Of course it's up to every single State, each driven by the demands and priorities of its own domestic agenda, to draw its own conclusion about the appropriateness of committing to the Treaty.

Nonetheless, I am reminded that dialogue was the first step on the path taken that led to the de-escalation of tensions between Cold War foes and their support for arms control.

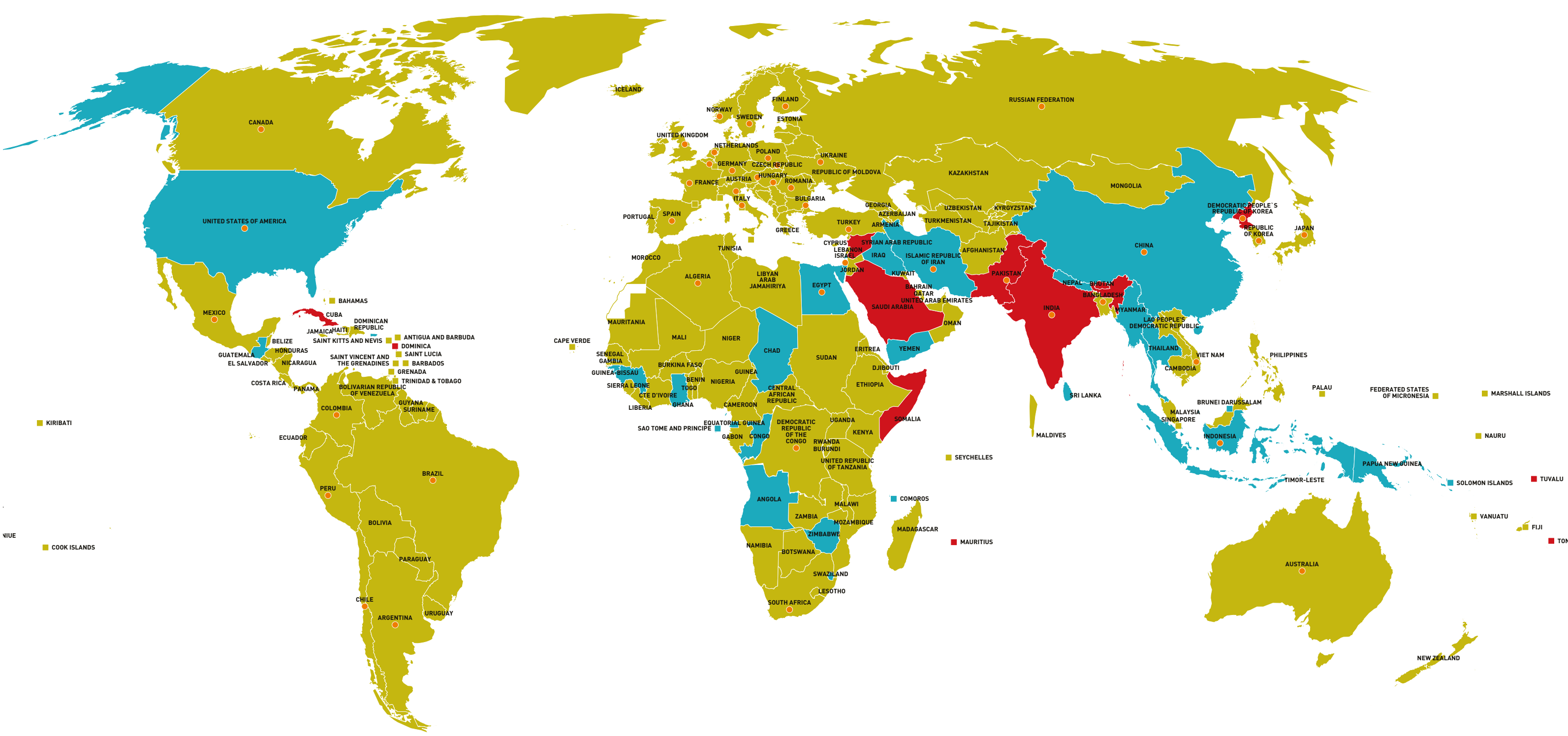
For it is from the exchange of views and acknowledgement of their commonalities that confidence is built.

The CTBT is a forum for such a process, further supported by a unique Earth-girdling verification regime driven by technology.

The equipment supporting one of those techniques, the detection of noble gas in an on-site inspection, is elaborated upon by Dr Charles Carrigan of the Lawrence Livermore National Laboratory. A team of scientific experts at the International Data Centre (IDC) of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) highlight the efficiency of the infrasound network. Michel Nambobona, the Director General of the National Data Centre in the Central African Republic, outlines his personal role in helping to secure CTBT ratification by his nation.

Finally, indulge me, please, if I misappropriate Alexander Pope's famous line. To err is human but nuclear weapons offer no divine forgiveness. So let us celebrate the discovery of Gliese 581g, perhaps the first real success story in our search for "living planets," by ensuring the future of that other "living planet," Earth.

STATUS OF SIGNATURES AND RATIFICATIONS
AS OF 27 OCTOBER 2010



	SIGNATORY STATES	RATIFYING STATES	NON-SIGNATORY STATES
TOTAL STATES: 195	182	153	13
● ANNEX 2 STATES: 44	41	35	3

FOR MORE DETAILED INFORMATION ON SIGNATURE AND RATIFICATION VISIT WWW.CTBTO.ORG/MAP

QUOTES

"We commit ourselves individually and together to make the Treaty a focus of attention at the highest political level and to take measures to facilitate the signature and ratification process as recommended in the 2010 NPT Review Conference Final Document."

JOINT MINISTERIAL STATEMENT
ON THE CTBT, SEPTEMBER 2010.
NEARLY 70 FOREIGN MINISTERS HAD ALREADY ENDORSED THE STATEMENT AS OF 27 OCTOBER 2010

"I wish to inform the present august assembly that Indonesia is initiating the process of the ratification of the Comprehensive Nuclear-Test-Ban Treaty. It is our fervent hope that this further demonstration of our commitment to the nuclear disarmament and non-proliferation agenda will encourage other countries that have not ratified the Treaty, to do the same."

MARTY NATALEGAWA
FOREIGN MINISTER OF INDONESIA,
NPT REVIEW CONFERENCE, MAY 2010

"I have called on numerous occasions for those States whose ratification is required for the Treaty's entry into force to act first without waiting for others to do so. We can no longer wait for the perfect international environment before taking advantage of existing – and potentially short-lived – opportunities. Be courageous. Take the initiative. Be the first mover."

BAN KI-MOON,
UN SECRETARY-GENERAL,
FIFTH MINISTERIAL MEETING,
SEPTEMBER 2010

"We reaffirm our determination to abide by our respective moratoria on nuclear test explosions before entry into force of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and call on all States to refrain from conducting a nuclear test explosion. The moratoria, though important, are not a substitute for legally binding commitments under the CTBT. We will continue our efforts aimed at early entry into force of the CTBT and achieving its universality and call upon all States that have not yet done so to sign and ratify this Treaty."

JOINT STATEMENT
TO THE NPT REVIEW CONFERENCE BY CHINA, FRANCE, THE RUSSIAN FEDERATION, THE UNITED KINGDOM AND THE UNITED STATES, MAY 2010

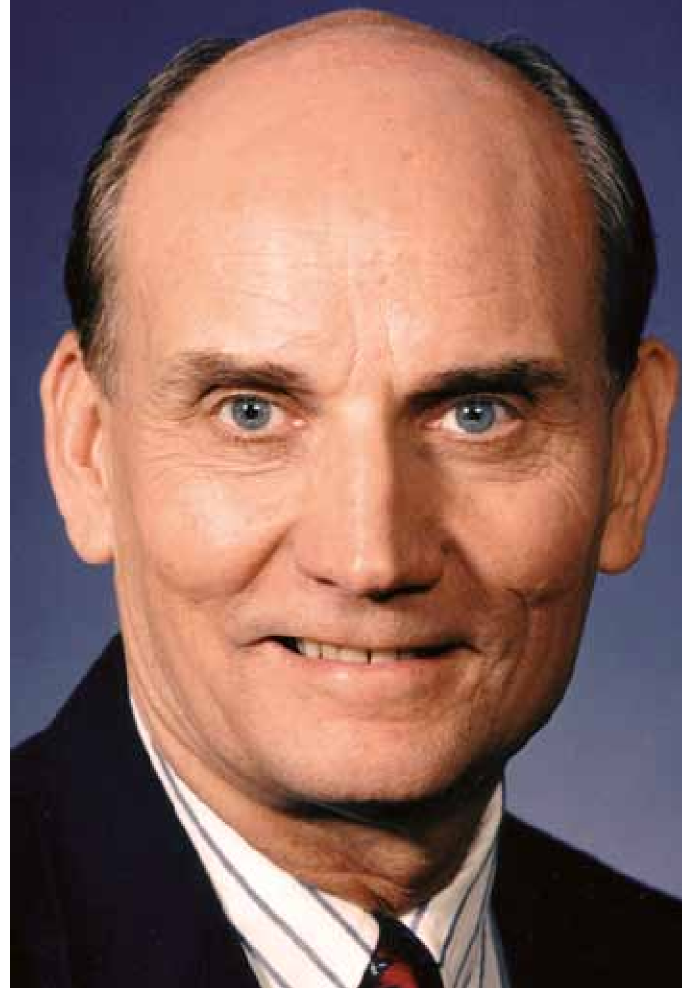
"The Conference reaffirms the vital importance of the entry into force of the Comprehensive Nuclear-Test-Ban Treaty as a core element of the international nuclear disarmament and non-proliferation regime."

FINAL DOCUMENT,
NPT REVIEW CONFERENCE,
ADOPTED BY 189 STATES,
MAY 2010

VOICES

Ratifying the CTBT is a critical step for the United States

BY SENATOR JAKE GARN



For a week in 1985, I joined the Space Shuttle Discovery in orbiting the Earth 109 times. This experience allowed me a unique perspective on the pace of technological advancement, and the nature of national and global security.

Viewing the Earth from space, you see neither borders nor nations; all the eye beholds is a small and fleeting glimpse of life. Nothing else threatens to extinguish that life so quickly and so permanently as nuclear weapons.

Since that experience, I have often reflected on the wisdom of President Ronald Reagan's statement: "The only value of possessing nuclear weapons is to make sure that they can't be used ever. I know I speak for people everywhere when I say our dream is to see the day when nuclear weapons will be banished from the face of the Earth."

With the Cold War 20 years behind us and a new set of nuclear dangers ahead, the United States should provide the leadership needed to stop the proliferation of nuclear weapons by permanently ending nuclear weapons testing and ratifying the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

FAILURE TO SECURE CTBT RATIFICATION IN 1999

Six years after I left Congress, the U.S. Senate briefly debated and voted on whether to provide its advice and consent for ratification of the CTBT.

Although the United States was the first signatory to the Treaty, we failed to secure ratification in 1999 partly due to concerns about monitoring a zero-yield global test ban with existing technology, and doubts about the ability of the United States to maintain existing nuclear warheads without a regular programme of nuclear test explosions. During debate, Republican Senator Orrin Hatch (Utah), who voted against the Treaty, presciently remarked that "there may be a day when my colleagues and I can be convinced that science-based technology can ensure the reliability and safety of our arsenal to a level that matches what we learn through testing. That would be a time to responsibly consider a Comprehensive Test Ban Treaty."

That day has arrived. The situation has changed dramatically in the last decade, and now is the responsible time for the United States – and all other Annex 2 States - to ratify the Comprehensive Nuclear-Test-Ban Treaty.

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THE U.S. NUCLEAR ARSENAL CAN BE MAINTAINED UNDER THE CTBT

In 1999, major elements of the United States' expanded Stockpile Stewardship Program were in the planning stages. Since then, results of the Stockpile Stewardship Program show that the U.S. nuclear arsenal can be maintained under a CTBT. Warhead life extension programmes have refurbished and recertified major warhead types, effectively extending their service lives. New studies demonstrate that plutonium parts in warheads are not affected by ageing for at least 85 years, much longer than previously thought. Limited production capacity can remanufacture new parts when needed, making new-design "replacement" warheads unnecessary. The Obama administration's 10-year plan for stockpile stewardship activities credibly demonstrates that resources will be available to maintain the existing arsenal if the Senate approves the CTBT.

NORTH KOREA'S 2009 TEST DETECTED BY 61 INTERNATIONAL MONITORING SYSTEM STATIONS

In 1999, there were only 20 monitoring stations in place around the world managed by the fledgling Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). Today, almost 280 of the 337 International Monitoring System facilities foreseen in the CTBT have been installed (with 258 already transmitting data to the International Data Centre in Vienna). These facilities are located in over 80 countries around the world and are capable of detecting underground nuclear explosions as small as 0.1 kilotons. In 2006, when North Korea tested a nuclear weapon, advancements in technology enabled the CTBTO to register the explosion accurately at more than 20 different sites within two hours of detonation. North Korea's second test, in 2009, was detected by 61 stations.

Banning nuclear weapons testing restricts the ability of nuclear-armed States to develop and demonstrate more advanced warhead designs and acts as a significant barrier to non-nuclear weapon States seeking the bomb. The CTBT will be able to conduct critical on-site inspections of nations suspected of testing once the Treaty enters into force. The Treaty also secures an international norm against testing that would inflict isolation, significant loss of prestige, and provoke prompt international sanctions.

SOME FORMER SKEPTICS NOW STRONGLY SUPPORT THE TREATY

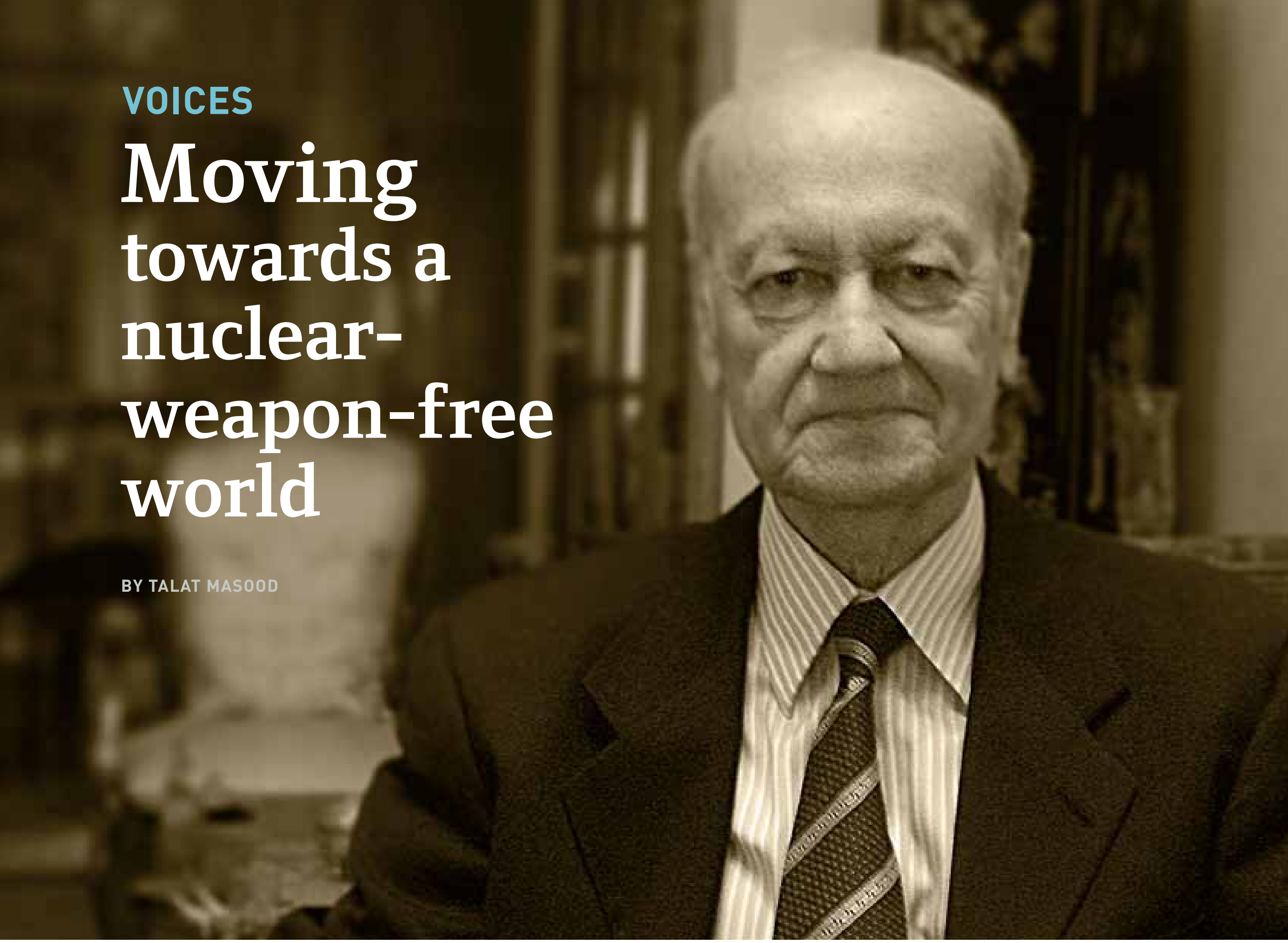
Former CTBT skeptics such as former National Security Advisor Brent Scowcroft and former Secretary of State, Henry Kissinger, are now ardent proponents of the Treaty. In the decade since the U.S. Senate rejected the Treaty, conditions have changed so dramatically that in the words of Ronald Reagan's former Secretary of State, George Shultz, some Republicans "might have been right voting against it [CTBT] some years ago, but they would be right voting for it now, based on these new facts."

As a former U.S. Senator as well as a U.S. Navy and U.S. Air Force pilot, I have always supported a strong national defense. As a man who gazed upon Earth from space and understands the threat nuclear weapons pose to all life on Earth, I recognize that ratifying the CTBT is a critical step for the United States and global efforts to reduce and eventually eliminate the nuclear weapons threat.

BIOGRAPHICAL NOTE

SENATOR JAKE GARN
served as a United States Senator representing the state of Utah from 1974 to 1993. Prior to his election as Senator, Mr. Garn was the Mayor of Salt Lake City, Utah, from 1972 to 1974. Senator Garn served as a pilot in the United States Navy and retired as a Brigadier General in 1979. He joined the Space Shuttle Discovery on its mission from 12 to 19 April 1985.

The first radioactive noble gas measurement system installed at RN75 in Charlottesville, United States, was certified on 19 August 2010.



VOICES

Moving towards a nuclear-weapon-free world

BY TALAT MASOOD

For the last 65 years, the world has become so used to nuclear weapons that the very thought of people talking about a world free of nuclear weapons was considered idealistic and unsettling, especially for those who have been hard proponents of nuclear theology. After the four former United States' iconic figures of the Cold War – senior statesmen George Shultz, William Perry, Henry Kissinger and Sam Nunn – wrote their first op-ed in the Wall Street Journal in January 2007, a movement for the elimination of nuclear weapons seems to be gradually gaining momentum.

DANGER OF A CATASTROPHIC NUCLEAR EXPLOSION

There is a growing realization that two main threats loom large over the horizon that could completely destroy humanity. One is climate change, affected by the world's heavy reliance on hydro-carbon fuels. The other is an even greater danger, posed by a catastrophic nuclear exchange either by design or accident.

The Nuclear Non-Proliferation Treaty (NPT) Review Conference in May 2010 provided a valuable opportunity to draw attention to the serious risks inherent with nuclear weapons and the urgent need to work collectively towards eliminating them. A world free of nuclear weapons was clearly articulated as a goal for the first time in the Conference and the final document, albeit modest, laid a framework for adopting a more comprehensive approach towards this objective.

UNITED STATES AND RUSSIA COMMIT TO NUCLEAR-WEAPON-FREE WORLD

In a historic joint statement in April 2009, U.S. President Obama and Russian President Medvedev committed their countries to achieving a nuclear-weapon-free world and subsequently made a modest beginning by signing the new Strategic Arms Reduction Treaty (START). Following the lead of the nuclear super powers, in September 2009 the United Nations Security Council unanimously adopted a resolution calling for the elimination of nuclear weapons.

The primary reason for this change is that whatever stabilizing impact nuclear weapons had during the Cold War has been superseded by

risks inherent in the proliferation of States possessing nuclear weapons and the related dangers of nuclear terrorism. The nature of the threat has also changed dramatically and nuclear weapons have no role in countering terrorism, cyber threats and asymmetric warfare. Nuclear weapons are only good for deterring nuclear weapons and giving a false sense of prestige but if there are no nuclear weapons, then they have no use. The demand for clean sources of energy has triggered a renaissance in civil nuclear energy and that, too, could result in an increase in the number of States possessing nuclear weapons.

GLOBAL ZERO URGES STATES TO SIGN/RATIFY CTBT

In parallel, prestigious organizations like Global Zero, the International Commission on Nuclear Non-proliferation and Disarmament, and Pugwash Conferences on Science and World Affairs, have been highly active in support of this goal. In pursuit of this aim, Global Zero convened a Summit in Paris in February 2010, inviting a galaxy of serving and former presidents, prime ministers, ministers, diplomats, generals and strategists from nuclear and non-nuclear countries. India and Pakistan were also well represented. In order to raise awareness about the escalating global nuclear arms crisis, Global Zero also released a documentary in May 2010 entitled “Countdown to Zero.” In the 1960s and 70s, the smartest minds had gone into the strategic field believing in strategic deterrence. It is a good omen that powerful minds are now engaged in finding ways of eliminating nuclear weapons.

The organizers of Global Zero presented a plan of action for developing hard-nosed, practical and comprehensive strategies for eliminating all nuclear weapons. This included a call to all nuclear capable countries to “move rapidly to cease nuclear explosive testing” by signing and/or ratifying the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

UNITED STATES AND RUSSIA HOLD ALMOST 95 PERCENT OF WORLD'S NUCLEAR WEAPONS

Much will, of course, depend on how soon the United States and Russia, who hold nearly 95 percent of the world’s nuclear weapons, ratify the new START and agree to take concrete measures on the further reduction and ultimate destruction of the weapons that both sides have agreed to reduce; only then might the nuclear non-proliferation

UN Secretary-General Ban Ki-moon, addressing the NPT Review Conference, New York, 3 May 2010.

and disarmament regime survive and bring about global strategic stability. Failure by the United States and Russia to live up to their disarmament obligations would place in doubt their commitment to Article VI of the NPT regime and provide States like Iran and other non-nuclear weapon States with the chance to acquire a nuclear weapon status.

PAKISTAN'S NUCLEAR PROGRAMME IS PRIMARILY INDIA SPECIFIC

In the near term, several other developments will influence the nuclear landscape. Progress has to be made on ratification of the CTBT by the United States and China and the lead has to come from the nuclear super power; only then will Beijing ratify. India considers itself as a global nuclear power and China as a potential threat and is building its nuclear arsenal and conventional capability accordingly. India is unlikely to sign until China and the United States ratify. As regards Pakistan, its nuclear programme is primarily India specific. It is therefore most likely that India and Pakistan will move once the United States and China ratify.

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Meanwhile, the South Asian nuclear rivals are adhering to a unilateral moratorium that they announced after the nuclear tests of May 1998. This needs to be formalized in a regional agreement or a joint statement indicating that both countries have no intention to conduct future tests. It would be a major confidence-building measure and will be useful for ongoing discussions on the CTBT.

Negotiations on a Fissile Material Cut-off Treaty (FMCT) have not started formally in the Conference on Disarmament (CD), although informal unstructured dialogue is apparently taking place. This is primarily due to the position adopted by Pakistan as it wants the agenda to be determined first before it is willing to participate in the discussions. In fact, Pakistan feels that there is a need for a Fissile Material Treaty wherein all aspects are dealt with instead of the current focus on the cut-off issue. By adopting this route, a comprehensive and equitable regime could be put in place that is verifiable and quantifiable.

THE INDO-U.S. NUCLEAR DEAL

The Indo-U.S. nuclear deal provides India with the opportunity to enhance its nuclear capabilities substantially. It will have the capability to build up stocks of fissile material at a faster pace as eight of its nuclear reactors are not under safeguards. Islamabad fears that once India is able to import nuclear fuel from abroad for its safeguarded nuclear plants, its domestic uranium could be diverted for the production of fissile materials for nuclear weapons.

Pakistan remains under a lot of pressure from the other CD Member States for blocking the formal proceedings and it may have been more appropriate if the same position was taken inside the Conference. Ironically, while India continues to build its nuclear weapons

The Global Zero Summit in Paris, 2 to 4 February 2010, was attended by around 200 international political, royal, military, business and faith leaders. Her Majesty Queen Noor of Jordan, former U.S. Secretary of State George Shultz, and the actor Michael Douglas, were in attendance.

arsenal to match China's capabilities and to build reserves of fissile material, it wants to gain time and finds Islamabad's position very convenient. Clearly, the best course for India and Pakistan should be to engage in meaningful dialogue on how best to allay each other's concerns and take a positive approach in the CD to make the world a safer place.

NUCLEAR DETERRENCE IS NO LONGER USEFUL

In principle, Pakistan is officially committed to general and complete nuclear disarmament but in reality, both India and Pakistan have strategic programmes. Pakistan's nuclear programme is based on the threat assessment in which conflict resolution with India is a central element. It also justifies its nuclear status to counter India's conventional superiority and the nuclear threat. India claims that it has a border dispute with China and an ongoing conflict over Kashmir with Pakistan. Regrettably, there are strong pressure groups in both these countries that continue to oppose any reduction or slow down in the nuclear programmes until they attain the limits of their doctrine of credible and minimum deterrence.

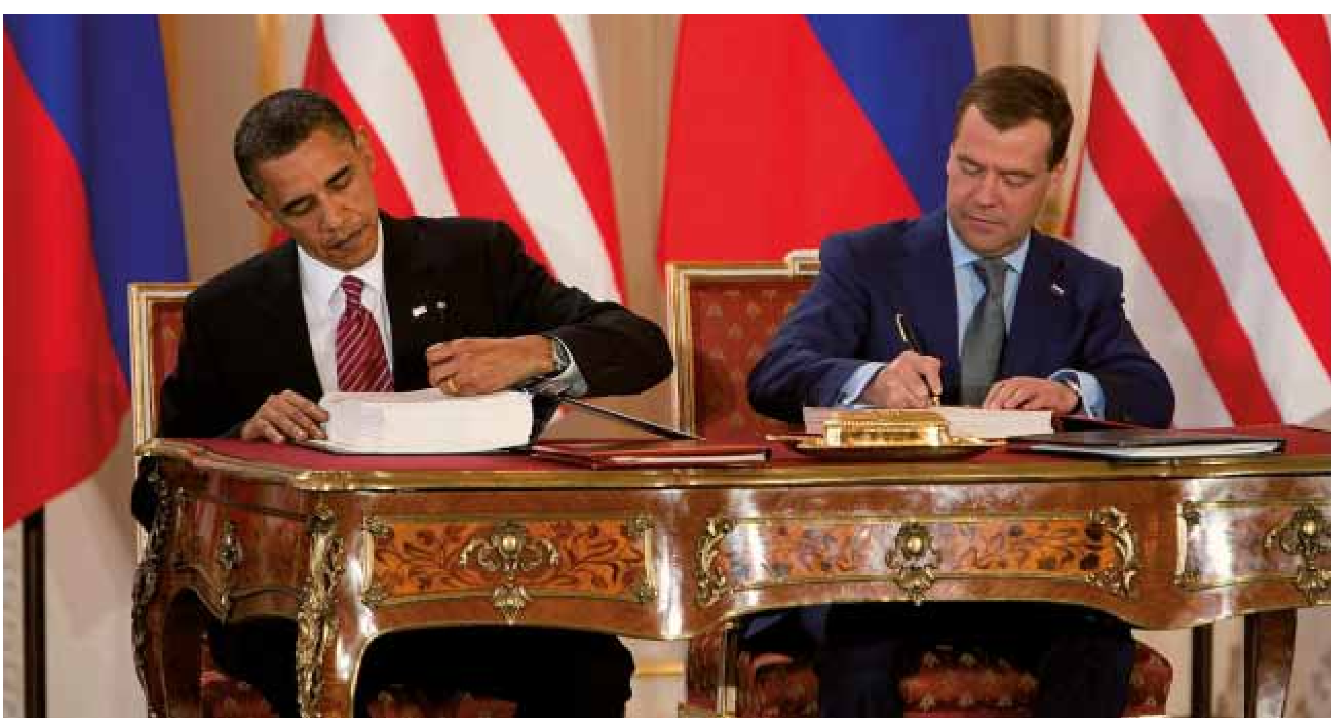
To countervail these forces, it is important that an effective public campaign be launched showing that nuclear deterrence is no longer very useful and that the dangers outweigh the benefits. However, it is likely that only when the United States and Russia have reduced their arsenals to 1,000 warheads or less and Britain, France, China and Israel agree to reduce their arsenals, that India and Pakistan may join disarmament negotiations. This is even though the long term interests of the two nations demand that India and Pakistan engage bilaterally on arms control measures at an earlier date and take rational measures that contribute towards nuclear stability.

NUCLEAR WEAPONS ARE MORE A WEAPON OF THE PAST THAN THE FUTURE

In order to influence the governments of nuclear weapon States to move towards a nuclear-weapon-free world, a global campaign for public awareness has to be initiated. Interest in the reduction and elimination of nuclear weapons must be revived in the public consciousness. Young people are uniquely placed to take the lead. Truly, nuclear weapons in a more pragmatic sense are more a weapon of the past than of the future. The time has come for the idea to be concretized to make our world a safer place. As Hans Blix, the Swedish politician/diplomat, once aptly remarked, the world has to find ways of moving away from "Mutually Assured Destruction" to an age of "Mutually Assured Stability", however daunting the challenge may be.

BIOGRAPHICAL NOTE

LIEUTENANT GENERAL TALAT MASOOD
served in the Pakistani Army for 39 years, retiring in 1990 as Secretary for Defence Production in the Ministry of Defence. Prior to this, Lt Gen Masood was chairman and chief executive of the Pakistan Ordnance Factories Board. He writes regularly on security and political issues for national newspapers and foreign magazines and is also a prominent commentator on national and international television and radio networks. Lt Gen Masood is the chief coordinator for Pugwash and its council member.



Presidents Barack Obama and Dmitry Medvedev sign the new START during a ceremony at Prague Castle in Prague, Czech Republic, 8 April, 2010. (Official White House Photo by Chuck Kennedy)

VOICES

The CTBT and China's New Security Concept

BY XIA LIPING

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is non-discriminatory in nature and embodies the principles of mutual trust, mutual benefit, equality and coordination, particularly with regard to equality in international security. Those principles are similar to China's New Security Concept, which was put forward by the Chinese government in 2002. China has held that the ways of thinking about security in the past are outdated, and "new concepts and means to seek and safeguard security" are required. According to China's New Security Concept, to ratify the CTBT will be in the strategic interests of China.

CTBT ENTRY INTO FORCE WILL ENHANCE CHINA'S SECURITY INTERESTS

To obtain lasting peace, it is imperative to abandon the Cold War mentality and seek new ways to safeguard peace. China stresses in its New Security Concept that countries should trust one another, work together to maintain security and to resolve disputes through dialogue and cooperation, and should not resort to the use or threat of use of force.

In the realm of arms control, the New Security Concept relies on broad international participation based upon justice, comprehensiveness, rationality, and balance in order to prevent the proliferation of weapons of mass destruction and uphold the international arms control and disarmament regime, of which the CTBT is a core element.

The CTBT's entry into force will enhance China's security interests by preventing an arms race that would provoke instability and threaten the global and regional strategic balance. China's ratification of the CTBT would help to solidify China's image as an open, transparent, and responsible nation, committed to following the road of peaceful development.

»Delinking China from the conservative arguments against the CTBT by proceeding with ratification would underscore China's non-proliferation and disarmament credentials.«

Some opponents of the CTBT in the United States have cited concerns over China's nuclear ambitions as specific examples of why the CTBT does not serve U.S. security interests. However, what they want is to use China as an excuse for the United States not to ratify the CTBT. So delinking China from the conservative

XINJIANG PROVINCE, WESTERN CHINA
River winding through the Kunlun mountain range, Xinjiang Province, Western China. China conducted its last nuclear test at the Lop Nur site in north western Xinjiang Province on 29 July 1996.

Photo: courtesy of Rhett A. Butler / mongabay.com

arguments against the CTBT by proceeding with ratification would underscore China's non-proliferation and disarmament credentials and help bolster the arguments being put forth by proponents of the test ban in the United States.

REINFORCING THE NPT REGIME

China's ratification of the CTBT would also strengthen the Nuclear Non-Proliferation Treaty (NPT) regime, and along with U.S. ratification, would provide the non-nuclear weapon States (NNWS) with a clear signal that the five nuclear weapon States (NWS) —China, France, Russia, the United Kingdom, and the United States — intend to fulfill their obligations under Article VI of the NPT. At the same time, moving forward with China's ratification would demonstrate to the world that Beijing understands the stakes involved in addressing nuclear proliferation and will respond to the challenge as a responsible global partner in the fight against it. CTBT ratification is one simple way to restore confidence in the grand bargain that promised access to nuclear power and progress towards nuclear disarmament in exchange for cooperation and participation in the objective of preventing nuclear proliferation.

EFFECTIVE MEASURES OF INTERNATIONAL VERIFICATION ARE KEY TO DISARMAMENT AGREEMENTS

With the evolving of the world order into a multi-polar system, multilateral verification mechanisms must become the new standard-bearer in arms control. The CTBT verification regime provides an ideal platform with which to progress towards multilateralism in arms control and international relations. The verification regime of the CTBT falls squarely in line with one of the principles outlined in the "Proposal on Essential Measures for an Immediate Halt to the Arms Race and for Disarmament," submitted to the United Nations by China in June 1982, which identified "strict and effective measures of international verification" as essential for any disarmament agreements. China's ratification of the CTBT, enhanced participation in the development of the international verification regime, and promotion of the Treaty's entry into force would demonstrate China's commitment to multilateralism in nuclear non-proliferation and disarmament, as well as buttress the United Nations based international system.

CHINESE INSTITUTIONS BENEFIT FROM CIVIL AND SCIENTIFIC APPLICATIONS OF VERIFICATION TECHNOLOGIES

Tongji University, one of leading universities in China, and many other universities and technical institutes in China, are poised to benefit greatly from the potential civil and scientific applications of verification technologies.

The data provided by the various elements of the International Monitoring System (IMS) have wide ranging applications which can be explored by the scientific community in China in order to enhance sustainable development, expand scientific knowledge, and improve human welfare. China's enormous population and fragile environment mean that it is a constant victim of climate change-induced natural disasters. Due to its reliance on agricultural food production as a fundamental element of its economy, China is particularly vulnerable to significant physical and socio-economic impacts of warming trends and wetter conditions across the country.

With extra bandwidth capacity at IMS facilities, additional sensor data could be transmitted for global climate monitoring, thereby creating an infrastructure specially calibrated to support sensors targetting the problem of climate change. IMS data which are archived in the process of monitoring for Treaty compliance and are not related to nuclear explosions would be relevant for research into phenomena that are affected by climate change, such as atmospheric shifts, severe storm systems, mountain waves, etc.

The four IMS technologies can play a role in climate change research in the following ways:

- Infrasound technology utilizes microbarographs to detect low-frequency sound waves that could contribute to climate change research by providing systematic studies on glacier movements, signals generated by landslides and avalanches, and seasonal and yearly variations of atmospheric properties, which will improve China's management of natural resources and decision-making on adaptation policies.

»China's ratification of the CTBT would help to solidify China's image as an open, transparent, and responsible nation, committed to following the road of peaceful development.«

- Radionuclide technology uses air samplers to detect radioactive particles and noble gases that are created by nuclear explosions. However, the air samplers also measure concentrations of specific natural radionuclides, which can increase understanding of the long-range exchange of pollutants through the atmosphere. The air samplers also provide information about the impact of megacities on climate change, which is particularly valuable for China, by determining the evolution of chemical contents in dust.

- Hydroacoustic technology collects data rich in background noise that can help improve weather prediction, support research on ocean processes and marine life, and measure ocean temperatures through the process of "acoustic thermometry", all contributing to research into climate change and its impact on the environment.

- Seismic technology is most useful for enhancing our understanding of the Earth's structure, but can also be utilized in the study of glacial melting and differences in wave travel time in the lower atmosphere, which are applicable to climate change research.

The IMS technologies can also be used for disaster mitigation in the following ways:

- The IMS data provided to Member States can assist with disaster management and response efforts by rapidly acquiring and disseminating data on earthquakes, in particular on potentially tsunami-generating earthquakes.

- Accurately identifying the location and magnitude of earthquakes allows for more efficient and timely emergency responses to affected areas and improves the capability to estimate the extent of the hazard.

Noble gas system, SPALAX, installed at radionuclide station RN20, Beijing, China.

Utilizing the seismic data collected and distributed through the IMS will enhance China's capability to mitigate the damage caused by earthquakes throughout its territory.

- Infrasound technology is uniquely suited to detect and locate volcanic ash plumes that have the potential to make jet engines malfunction or even stall completely. Data generated by infrasound stations are also useful in monitoring and tracking severe storms, which can enhance preparedness efforts by Chinese central and local authorities.

OPPORTUNITIES FOR CAPACITY DEVELOPMENT

The highly complex nature of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and its verification regime require that the organization commands a variety of specialized technical capabilities.

The capacity development activities will expand the CTBTO's virtual training activities through comprehensive e-learning modules with access to internet based lectures and tutorials. The objective is to encompass a broader audience with interests in certain specific areas, thereby providing users with different programme modules that meet their respective needs.

This is a participatory and dynamic process that will rely on reaching out to relevant institutions in Member States, where scientists, engineers, and other technicians will obtain practical experience and enhance their expertise through a knowledge exchange programme, all while providing a valuable contribution to the CTBTO.

By participating in the capacity development activities and utilizing the various monitoring data provided by the CTBTO's verification regime, Tongji University could strengthen its scientific capabilities and enhance the prestige of Tongji University's Schools and Departments, such as the School of Ocean and Earth Science.

BIOGRAPHICAL NOTE

XIA LIPING
is Dean and Professor of the School of Political Science & International Relations at Tongji University in Shanghai, China. He is also General-Secretary of the Shanghai Institute for International Strategic Studies (SIISS), Vice Chairman of the Shanghai Association of International Studies, and Vice President of the Shanghai Center for RimPac Strategic and International Studies (CPSIS). Professor Xia specializes in Asian security and nuclear non-proliferation and China's foreign policy strategy

A 6.9 magnitude earthquake on 14 April 2010 caused devastation in Yushu county in western China's Qinghai province.

STATUS OF CERTIFIED IMS FACILITIES
AS OF 27 OCTOBER 2010

CERTIFIED	TESTING **	UNDER CONSTRUCTION	PLANNED	TOTAL
258	20	26	33	337

- Primary Seismic
- Auxiliary Seismic
- Infrasound
- Hydroacoustic
- Radionuclide
- Radionuclide with Noble Gas *
- Radionuclide Laboratories

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MILESTONE EVENTS
in the history of nuclear testing.

...and much more!

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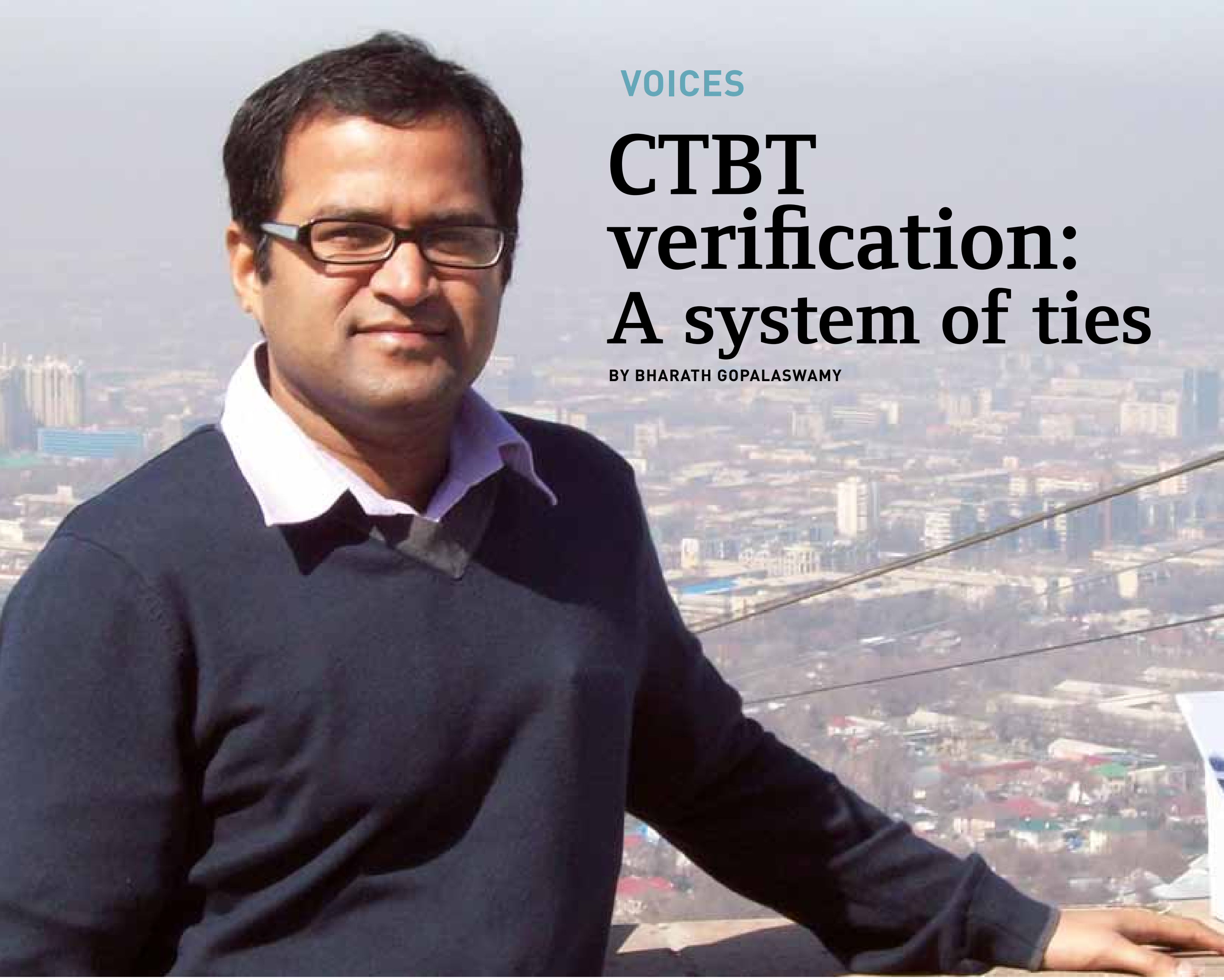


VOICES

CTBT verification: A system of ties

BY BHARATH GOPALASWAMY

With Indonesia's decision to start the ratification process of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in May 2010, ratifications from only eight more nations will be needed before the Treaty can enter into force: China, the Democratic People's Republic of Korea, Egypt, India, Iran, Israel, Pakistan and the United States. Nearly all of them have expressed their support for the CTBT's entry into force by signing the Treaty and through documents adopted by the CTBT entry into force conferences, the Nuclear Non-Proliferation Treaty Review conferences, or United Nations General Assembly resolutions. The countries mentioned above have given various different reasons for not having ratified the Treaty yet. One argument claimed by a few has been that parts of the CTBT verification regime could be used for espionage. However, by taking a look at the Treaty text itself, as well as its negotiating history and the use of the CTBT monitoring system since the Treaty opened for signature in 1996, it is evident that such concerns are baseless.

The Treaty and its verification regime strike a careful balance between fulfilling the CTBT's mandate, i.e. detecting any nuclear explosion anywhere by anyone, while at the same time ensuring that Member States' legitimate national security interests are not endangered.

WEALTH OF CIVIL & SCIENTIFIC APPLICATIONS

The CTBT's technologies and verification methods have capabilities that can monitor events other than nuclear explosions. This is unavoidable. In the search for the needle in the haystack (i.e. a nuclear explosion), the IMS registers a large number of other events, mainly earthquakes, but also various natural and man-made events such as mining explosions, large chemical explosions, meteors and storms.

Data generated by the monitoring stations have a number of potential civil and scientific applications, especially in the field of disaster mitigation. Seismic data already help provide earlier tsunami warnings while infrasound data could help improve civil aviation safety by warning pilots of large ash plumes caused by volcanic eruptions. IMS verification data could also be used for climate change research, research on the Earth's structure, monitoring underwater volcanic explosions, ice shelf break-up and the creation of large icebergs.

THE VERIFICATION REGIME

The CTBT prohibits all nuclear explosions anywhere by anyone. The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is tasked with facilitating the Treaty's entry into force and developing its verification regime. The regime consists of several components, including the International Monitoring System (IMS), the International Data Centre (IDC), and provisions for on-site inspections.

As of 27 October 2010, 258 IMS stations were fully operational and sending data to the IDC in Vienna for analysis. Data are collected using four key verification technologies: seismic, hydroacoustic, infrasound, and radionuclide. When complete, the IMS will comprise 321 stations: 50 primary and 120 auxiliary seismic, 11 hydroacoustic, 60 infrasound, and 80 radionuclide stations. Sixteen laboratories for radionuclide analysis are also part of the system. The facilities are located strategically around the world in over 80 countries and monitor the globe for any sign of a nuclear explosion, providing States with an effective and reliable verification mechanism.

Once the CTBT enters into force, an on-site inspection (OSI) can be carried out as a final verification measure. Requests for an OSI must be approved by at least 30 of the CTBTO's 51-member Executive Council.

»Countries outside the Treaty are at a serious disadvantage by not having access to collected data and the "know-how" of experts who analyze it«

CTBT NEGOTIATIONS AND THE USE OF NATIONAL TECHNICAL MEANS (NTM)

During the negotiations for the CTBT, countries such as China, India, Iran, Israel and Pakistan expressed concern about the potential use of the Treaty's verification regime for espionage purposes, especially through the use of National Technical Means (NTM). The reason that negotiators agreed to allow Member States to use their own NTM (which include monitoring methods such as satellite imagery analysis and radars) to detect potential Treaty violators was that a CTBT-specific satellite system was regarded as prohibitively expensive. Furthermore, the majority of the delegations felt that the CTBTO would be able to acquire necessary information from national and commercial satellites. China argued that NTM could include detection devices that could be construed as forms of espionage. India and Pakistan joined China in opposing the incorporation and legitimization of NTM, fearing that information acquired in this way would not necessarily be shared and could give some States an advantage over others.

However, in a statement to the Conference on Disarmament (CD) on 1 August 1996, Sha Zukang, China's Ambassador to the CD, finally conceded to the use of NTM, saying: "On the issue of national technical means (NTM), China has consistently opposed in the past two years and more the concept of allowing NTM to play a role in the CTBT verification regime, particularly in the triggering of OSIs. With a drastic adjustment of its position China can now agree to allow purely technical NTM to play a supplementary role in triggering OSIs." When China signed the CTBT

Raw data and analysis results are distributed by the IDC in Vienna to the CTBTO's Member States.

on 24 September 1996, it submitted a declaration stating its opposition to "the abuse of verification rights by any country, including the use of espionage or human intelligence to infringe on the sovereignty of China." Although Iran was a staunch opponent of NTM, it signed the Treaty on the same day as China, while declaring that "National Technical Means should not be interpreted to include information received from espionage and human intelligence."

ON-SITE INSPECTIONS AS A FINAL VERIFICATION MEASURE

During the Treaty negotiations, another contentious issue was that in the event of an on-site inspection (OSI), the Member State subject to an inspection may be required to open its military or other sensitive areas to inspectors as well as a representative from the country requesting the inspection. China, India, Israel and Pakistan argued that an OSI should be a tool of last resort, used rarely, and only undertaken if a mandatory period of consultations failed to resolve an ambiguous data record or suspicious event. Israel pushed for inspected State Parties to have the right to "exclude locations and facilities at the initial stage" of an inspection and "to exempt sensitive facilities from access on the basis of national security, proprietary rights and health and safety reasons." China finally agreed to the provision of on-site inspections. Israel also signed the Treaty on 25 September 1996.

COUNTRIES' LEGITIMATE SECURITY CONCERNS PROTECTED

In all these cases, it is important to remember that the CTBT was negotiated to detect any nuclear explosion, regardless of yield. It is a zero-yield treaty. The final language in the Treaty text was carefully crafted to enable the Treaty to fulfill its mandate. At the same time, the negotiators took into consideration those concerns expressed at the CD, making sure that countries' legitimate security concerns were also protected. There are legal, technical, and political reasons that support this.

The Treaty requires the CTBTO to conduct its verification activities in the least intrusive way possible. The general provisions of the Treaty stipulate that the CTBTO "shall request only the information and data necessary to fulfil its responsibilities under this Treaty. It shall take every precaution to protect the confidentiality of information on civil and military activities and facilities coming to its knowledge in the implementation of this Treaty and, in particular, shall abide by the confidentiality provisions set forth in this Treaty." Furthermore, under Article IV. 12 of the CTBT: "State Parties undertake to promote cooperation among themselves to facilitate and participate in the fullest possible exchange relating to technologies used in the verification of this Treaty in order

Central site of IMS hydroacoustic station HA09, Tristan da Cunha.

to enable all States Parties to strengthen their national implementation of verification measures and to benefit from the application of such technologies for peaceful purposes."

With regards to OSI verification activities, inspected State Parties are granted "managed access" rights whereby a State can take appropriate "measures to protect sensitive installations and locations" as well as preventing "disclosure of confidential information not related to the purpose of the inspection." Mechanisms also exist within the Treaty to prevent frivolous or abusive inspections, with ways of reprimanding a State for making illegitimate requests.

STATES WITH BETTER NTM CANNOT REQUEST MORE OSIs

Because some countries have better developed NTM than others, they have the advantage of being able to collect more data. This does not, however, mean that that they have discriminatory powers to request more OSIs. In the final text of the Treaty, Member States agreed that in order to request an OSI, they would allow information to be collected by NTM "in a manner consistent with generally recognized principles of international law" as well as data from the IMS stations. In this way the IMS and NTM technologies combine to make intelligence gathering a synergistic operation.

MULTIPLE TECHNOLOGIES IMPROVE RELIABILITY OF THE INTERNATIONAL MONITORING SYSTEM

The IMS technologies are very reliable and have been developed to detect nuclear explosions in all environments. The three waveform technologies (infrasound, seismology, and hydroacoustic) can detect, locate, and identify explosions in the atmosphere, underground, and underwater. However, these three technologies alone cannot determine with certainty whether the source of an explosion is nuclear; such a confirmation is obtained by the IMS radionuclide system.

»CTBTO Member States have the advantage of participating in verification processes at the IDC in Vienna«

Multiple technologies improve the reliability of the system and help avoid situations such as the August 1997 incident, when U.S. officials claimed an earthquake off Novaya Zemlya (a former nuclear test site used by the USSR) was actually a nuclear test. Data from IMS seismic stations in Norway, Sweden, Finland, and Russia, and analyses from independent scientists, led to the clear conclusion that the seismic event was an earthquake, not a nuclear explosion.

DATA DISTRIBUTED IN AN EQUAL AND NON-DISCRIMINATORY WAY

The IMS proved its worth again in 2006 and 2009. When North Korea tested a nuclear device in October 2006, 22 IMS sensors detected the event within seconds. The final confirmation that a test had occurred came when a radionuclide monitoring station in Yellowknife, Canada, detected traces of radioactive xenon. Through state-of the-art atmospheric modelling, the noble gas release was traced back to North Korea. In May 2009, North Korea conducted what it called a "successful nuclear explosion." The event was once again recorded by IMS sensors all around the world (61 this time); however, the lack of detection of radioactive xenon gas by anyone emphasized the necessity of the verification regime's OSI component.

CTBTO Member States have the advantage of participating in verification processes at the CTBTO's IDC in Vienna, where in-house experts provide substantial data filtering and analysis. This ensures that those Member States that have limited technical capabilities gain experience in analyzing data. Capacity building and training provided by the CTBTO enable all Member States to participate in the decision making process on an equal footing. CTBTO data are distributed to all Member States in an equal and non-discriminatory way. At the time of the DPRK tests in 2006 and 2009, the members of the UN Security Council – nuclear weapon and non-nuclear weapon States alike, had the same information about the location, magnitude, time and depth of the tests hours before the deliberations in the Council. Remaining outside the CTBT means that a State will not have access to such data or these benefits.

MEMBER STATES HAVE FULL ACCESS TO ALL DATA

It is beneficial for States to become members of the CTBTO. Member States are informed about the technical implications of membership, can receive assistance with the establishment of a National Data Centre, and participate in the CTBTO's decision-making structures.

The monitoring system gathers data through sensors which detect and register events. This process is entirely automatic. Once the data reach the IDC, the responsibility shifts to data analysis, whereby the analyst discards events which are not real, adds signals which have not been associated to an event, and corrects and improves the location estimates of real events. Member States have the right of full access to

Participants attending the National Data Centre Development Workshop for Middle Eastern and South Asian States, Amman, Jordan, 27 to 30 September 2010.

all monitoring data and data bulletins, which can assist a State in exercising its prerogative to make the final judgment in the case of a suspicious event. Countries outside the Treaty are at a serious disadvantage by not having access to collected data and the "know-how" of experts who analyze it.

UNIQUE GLOBAL MONITORING SYSTEM

The CTBTO is establishing an unparalleled verification regime that is approaching completion. The IMS sensors are global, and the network's operating conditions are stringent and highly reliable. Furthermore, the system is multilateral, which enhances the legitimacy of the verification mechanisms. Such an arrangement grants all CTBTO Member States equal access to the monitoring data, allowing them to analyze ambiguous events, pass final judgment on the nature of the event, and decide if they wish to request further measures such as OSIs.

The Treaty is now close to universalization, with 182 signatures and 153 ratifications. Any State that remains outside the CTBT based on fears that the Treaty's verification regime might be used for espionage should take these facts into consideration, for there is no indication that this has ever occurred or will ever occur.

BIOGRAPHICAL NOTE

BHARATH GOPALASWAMY joined the Arms Control and Nonproliferation program of the Stockholm International Peace Research Institute (SIPRI) in 2009. Prior to that, he was a postdoctoral associate at Cornell University's Peace Studies Program, where he applied his technical knowledge to current foreign policy issues. Dr Gopalaswamy has also worked at the Indian Space Research Organization's High Altitude Test Facilities and the European Aeronautics Defense and Space Company's Astrium GmbH division in Germany.

Employment opportunities

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is currently establishing a global verification regime to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty. Great progress has been made since 1996 thanks to the extensive skills and experience of the CTBTO's international workforce.

As we strive to reach our goal to end all nuclear explosions once and for all, we welcome applications from suitably qualified individuals committed to helping us achieve this objective. Exciting opportunities exist for professionals in a range of disciplines, and we are particularly interested in candidates with strong scientific and technical backgrounds.

OUR STRENGTH LIES IN THE QUALITY OF OUR PEOPLE.

Visit our website now for more information. www.ctbto.org

Charles Carrigan taking a sample of gas during infiltration experiment, NG09, October 2009.

2009 Noble Gas Field Operations Test:

Towards detecting "the smoking gun" during an on-site inspection

BY CHARLES CARRIGAN

Suppose you were transported along with 39 other people to a remote location in the world and asked to determine if an underground nuclear explosion had recently occurred. What would you look for? This question captured my imagination the first time I was confronted with the concept of an on-site inspection (OSI) 15 years ago.

Once the Comprehensive Nuclear-Test-Ban Treaty (CTBT) has entered into force, any Member State of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) can request an OSI if it suspects that another Member State has conducted a nuclear explosion. The area to be inspected may not exceed 1,000 square kilometres. If the OSI is granted by the CTBTO's executive body[1], up to 40 inspectors and their equipment will be transported to the area in question to commence searching for evidence of the nuclear test. The target of their search may be entirely contained beneath an area of only hundreds of square metres hidden somewhere in the vast permitted search area.

Before succumbing to the vision of a needle in a haystack, it is important to point out that the seismic and radionuclide detection capabilities of the CTBT's worldwide International Monitoring System (IMS) will probably have provided a good indication of the most likely places to look within the allowable search zone. If detonation products have leaked to the surface, gamma-radiation surveys can further help isolate the testing site. Localization may also result from over-flight observations as well as from distributed seismograph arrays set up within the total OSI search area that use post-explosion seismicity to pinpoint the underground location of the test. Finally, geophysical methods, similar to those used for mineral exploration, may also be employed in the search for the suspect site.

MOST OBSERVATIONS ARE NOT UNIQUE TO AN UNDERGROUND NUCLEAR EXPLOSION

The activities described above can only locate the site of a possible violation. None of the methods mentioned can demonstrate conclusively that an underground nuclear explosion has actually taken place. This is because virtually all these observations are not unique to such an explosion. For example, underground explosions and their associated seismicity are common in the mining industry. Tunnels or boreholes containing electrical cables may be visual cues of an underground nuclear explosion or

[1] Once the CTBT enters into force, the Executive Council (EC) will act as the Treaty's principal decision-making body. It will consist of 51 members. Its main duties will be to promote the effective implementation of, and compliance with, the Treaty, and to oversee the affairs of the CTBTO. The EC will also receive, consider, and take action on requests for, and reports on, OSIs.

just mining, water-well pumping or construction activities. Even observations of nuclear radiation at the surface do not necessarily prove that a detonation has occurred recently. Legitimate nuclear processing operations or even old, pre-CTBT testing may be explanations of such observations. At this point, the hypothetical 40 inspectors have not found the incontrovertible evidence needed to show that a violation of the Treaty has occurred.

»Detecting significant levels of [radioactive noble] gases in the soil overlying a suspected underground test site is the best evidence – with the highest level of certainty – that a nuclear explosion has occurred very recently «

METHODS TESTED TO CONFIRM RECENT NUCLEAR EXPLOSION ACTIVITY

Obtaining this "smoking gun" evidence of a violation of the CTBT is the primary goal of the equipment and activities that were recently evaluated in the CTBTO's 2009 Noble Gas Field Operations Test (NG09), held near Stupava, Slovakia. Underground nuclear explosions produce some extremely rare radioactive noble gases – isotopes of xenon and argon – that serve as excellent tell-tale indicators of very recent nuclear explosion activity. Gases produced by such explosions rapidly disappear in days or weeks by decaying into other elements. Thus, detecting significant levels of these gases in the soil overlying a suspected underground test site is the best evidence – with the highest level of certainty – that a nuclear explosion has occurred very recently.

It is within the capability of current OSI technology to detect concentrations of these gases falling below about one part in 10^{20} (1 followed by 20 zeros). This is less than the concentration that would result from mixing an amount of fluid the size of a ping-pong ball into a volume equal to that of all the Great Lakes in the United States. During an OSI, the analytical equipment capable of making these measurements is housed and operated in temporary labs set up at the base of operations of an inspection area. Tanks of gas extracted through tubes augered or driven several metres into the soil of the site of a suspected violation provide the samples that are analyzed by this equipment. Air samples are also taken to search for radioactive gases that may be seeping or venting from an undergroud nuclear

Augering a shallow hole as a prelimnary to setting up a noble gas sampling site during NG09.

explosion into the atmosphere. NG09, involving more than 40 researchers and observers from 17 countries including staff from the CTBTO, was about evaluating the operational challenges of preparing soil gas sampling stations, sampling soil and atmospheric gases and then analyzing them under both Treaty- and field-imposed conditions that might apply to a real OSI. The field test complemented the experience of the Integrated Field Exercise 2008 (IFE08)[2], which focused more on geophysical, observational and surface sampling techniques.

REALISTIC SCENARIO CREATED IN THE SLOVAKIAN COUNTRYSIDE

The base of operations for the 10-day field experiment was set up in a hotel in the Slovakian countryside that had an indoor sports facility which was used to house several different prototypes of noble gas analyzers from China, Russia and Sweden. Participants were divided into teams that focused on soil gas sample-site preparation, subsurface sampling, atmospheric sampling, noble gas analysis and logistics. The Slovak military kindly provided the main field site for the operations test at a nearby army base.

On a typical day, one team might install soil gas sampling sites followed by other teams who would draw gas samples from the soil or the air. The samples were then returned to the base of operations for an analysis that would be used during a real OSI to look for the argon and xenon gases of interest. While the tell-tale gases of an underground nuclear explosion were not present in the operations test, most of the other elements needed to make the event realistic were present, including working amidst snow storms.

[2] For more information about the IFE08, please see www.ctbto.org/specials/integrated-field-exercise-2008/

SAUNA analyzer (Xenon) during NG09.

With respect to the techniques used for collecting a gas sample from the subsurface at the suspected site of an underground nuclear explosion, we found that the large volume (~ 1 m^3) of soil gas required for each sample enhances the possibility of dilution and contamination by atmospheric gases unless adequate precautions are taken during the extraction of the sample. Finally, because NG09 was the first exercise of its kind to integrate such a broad spectrum of OSI noble gas equipment, techniques and global expertise in a real-world field situation, we learned some very useful things about optimizing the value of future exercises. These are but a few of the many lessons that have already been gleaned from the events of last October.

To me, NG09 demonstrated that before we can achieve the desired "smoking gun" level of certainty in detecting an underground nuclear explosion under the most challenging of conditions that we might expect to encounter during an OSI, some components of the noble gas detection methodology must benefit from further development and testing. I also believe that this event serves as an excellent example of the kind of international scientific cooperation needed to ensure that noble gas detection methods will be practical and definitive under a broad range of challenging field and operational conditions.

NUMBER OF IMPORTANT LESSONS LEARNED

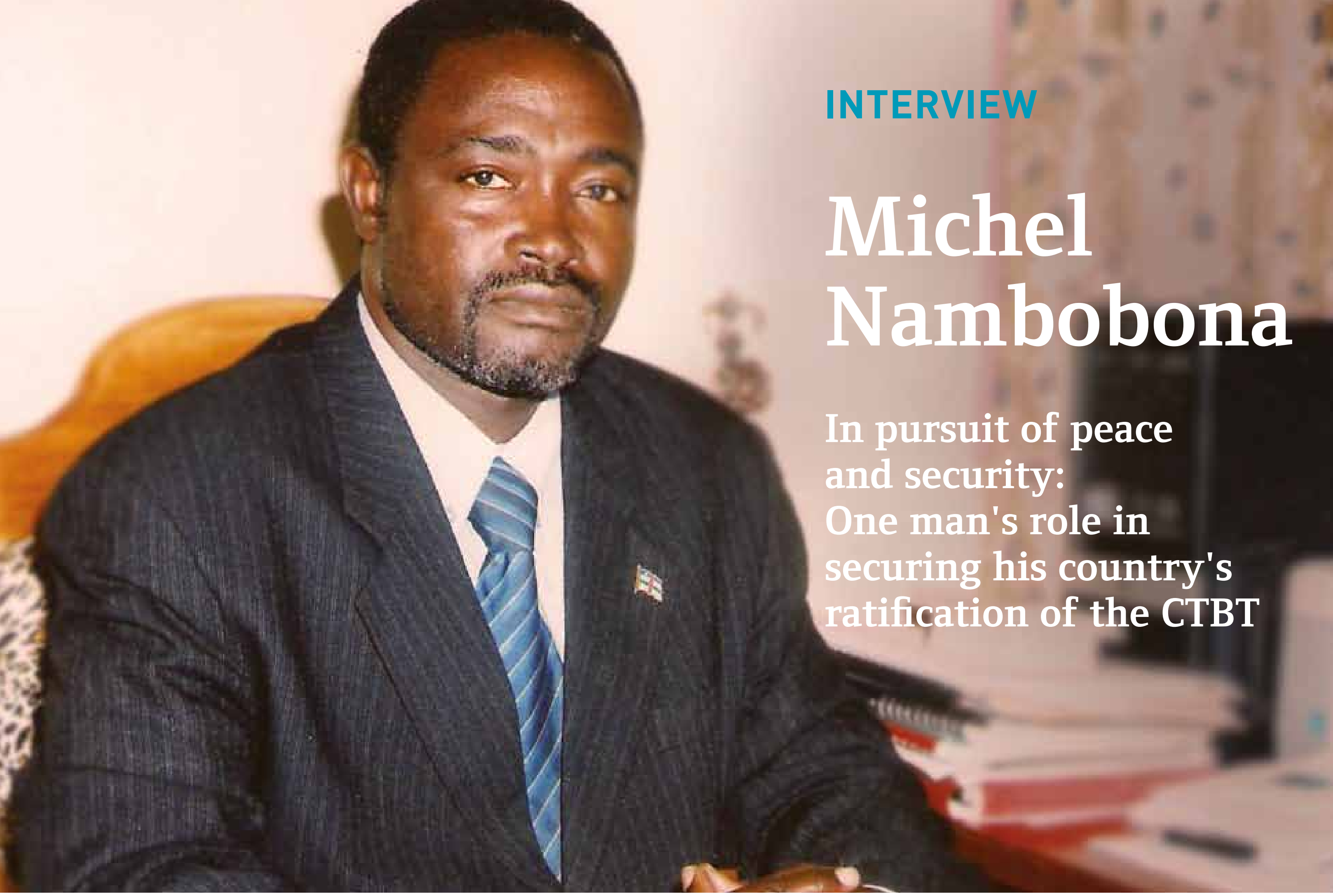
Proper utilization of the typically complicated suite of techniques and equipment exercised in NG09 requires a wide range of technical expertise. Since the completion of the field test in October 2009, the results have been analyzed by a similarly wide range of technical experts, yielding a number of important lessons. For example, we learned that extremely valuable time and effort in the field can be saved by performing all initial processing of gas samples at the base of operations and not in the field. Also, possible damage to critical processing equipment can be avoided by leaving it set up at the base to perform its tasks rather than transporting it to a sampling site.

We learned that hand-augering even shallow holes to set up soil gas sampling sites is labour intensive and may need to be performed many tens of times over large areas, suggesting the need for a small, rapidly deployed, vehicle-mounted augering system. We also learned the very practical lesson that collecting, transporting and processing gas samples in pressure-rated metal tanks, such as those used by divers, is far more efficient than using large bulky plastic sample bags.

Preparation and quality check for noble gas sampling point during NG09.

BIOGRAPHICAL NOTE

CHARLES CARRIGAN
is a geophysicist who participated in the 1993 Non-Proliferation Experiment (NPE) involving a buried thousand-ton chemical explosion at the Nevada Test Site in the United States that helped to demonstrate the feasibility of finding rare noble gases during an OSI. Dr Carrigan is a member of the U.S. delegation attending the CTBTO's meetings concerned with verification issues. He also conducts research on greenhouse gas sequestration and geothermal energy and studies volcanoes.



INTERVIEW

Michel Nambobona

In pursuit of peace and security: One man's role in securing his country's ratification of the CTBT

»When I realized the great danger posed by nuclear weapons, I became aware of the importance of ratifying the CTBT.«

When the Central African Republic ratified the Comprehensive Nuclear-Test-Ban Treaty (CTBT) on 26 May 2010, the number of ratifications by African States increased to 38. A total of 51 of the 53 countries in Africa have already signed the CTBT. You played a key role in ensuring that the ratification process was completed. Exactly what did this entail?

My personal role in securing ratification of the CTBT by the relevant authorities in the Central African Republic (CAR) began on 6 June 2003. At that time, I was working at the Geophysical Observatory in Bangui as an engineering geologist. Over the next few years, I sent a series of letters to the heads of ministerial departments explaining the importance of ratifying the CTBT. I also highlighted the activities being carried out by the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). However, despite all my efforts, I was unable to solicit the support that I required.

In February 2009, I was appointed Director of Electricity and Hydrocarbons at the Ministry of Mines, Energy and Hydraulics. My experience in the field of nuclear monitoring and verification activities related to the CTBTO also enabled me to serve as Deputy Coordinator of the National Radiation Protection Agency (ANR). I was responsible for processing documents related to electricity, hydrocarbons and the safety and security of radioactive materials. In fulfilling these functions, I became acquainted with people who enabled me to pursue the CTBT issue. From May 2009, I started raising awareness and interest within the Ministry of Mines about the importance of the CTBTO and of ratifying the Treaty.

I was fortunate to have the opportunity in June 2009 to explain the important role of the CTBT's International Monitoring System (IMS) to Lieutenant-Colonel Sylvain Ndoutingaï, the State Minister of Mines, Energy and Hydraulics, when I was assigned to advise him about the International Centre of Seismic Safety.

Two IMS stations, which are part of a 337-facility global network, are to be hosted by my country: a primary seismic station[1] PS11, which has already been established, and a new infrasound station IS12, which will be constructed in Bangui. Convinced of the importance of seismic monitoring, the non-proliferation and disarmament of nuclear weapons, and safeguarding international security and peace, the State Minister ordered that a document be issued to the Council of Ministers.

This document, which explained the CTBTO's activities and benefits for the States hosting IMS stations, such as technical support and the creation of National Data Centres where necessary, was adopted without amendment by the Council of Ministers in November 2009. After that, an Explanatory Memorandum on the bill and the instrument of ratification of the CTBT were presented and defended by the State Minister to the National Assembly. They both received the full approval of the government led by President François Bozize and Prime Minister Faustin Archange Touadera. On 13 April 2010, the National Assembly endorsed the Explanatory Memorandum on the bill and the instrument of ratification of the CTBT. Finally, on 23 April 2010, President Bozize enacted the law and the instrument of ratification. I personally brought the documentation with a Note Verbale from the Ministry of Foreign Affairs when I travelled to Vienna to participate in a Technical Training Programme organized by the CTBTO from 17 to 28 May 2010. All of these documents were then sent by CTBTO staff to the United Nations Secretary-General, Ban Ki-moon, who is also the Depository of the Treaty.

Ratification was a victory for the Central African Republic and for all those involved both directly and indirectly in the ratification process. On 26 May 2010 when the instrument of ratification was deposited in New York, the UN Secretary-General declared the CAR as the 153rd State to ratify the CTBT and acknowledged that my country is fully engaged in the struggle for international security and peace.

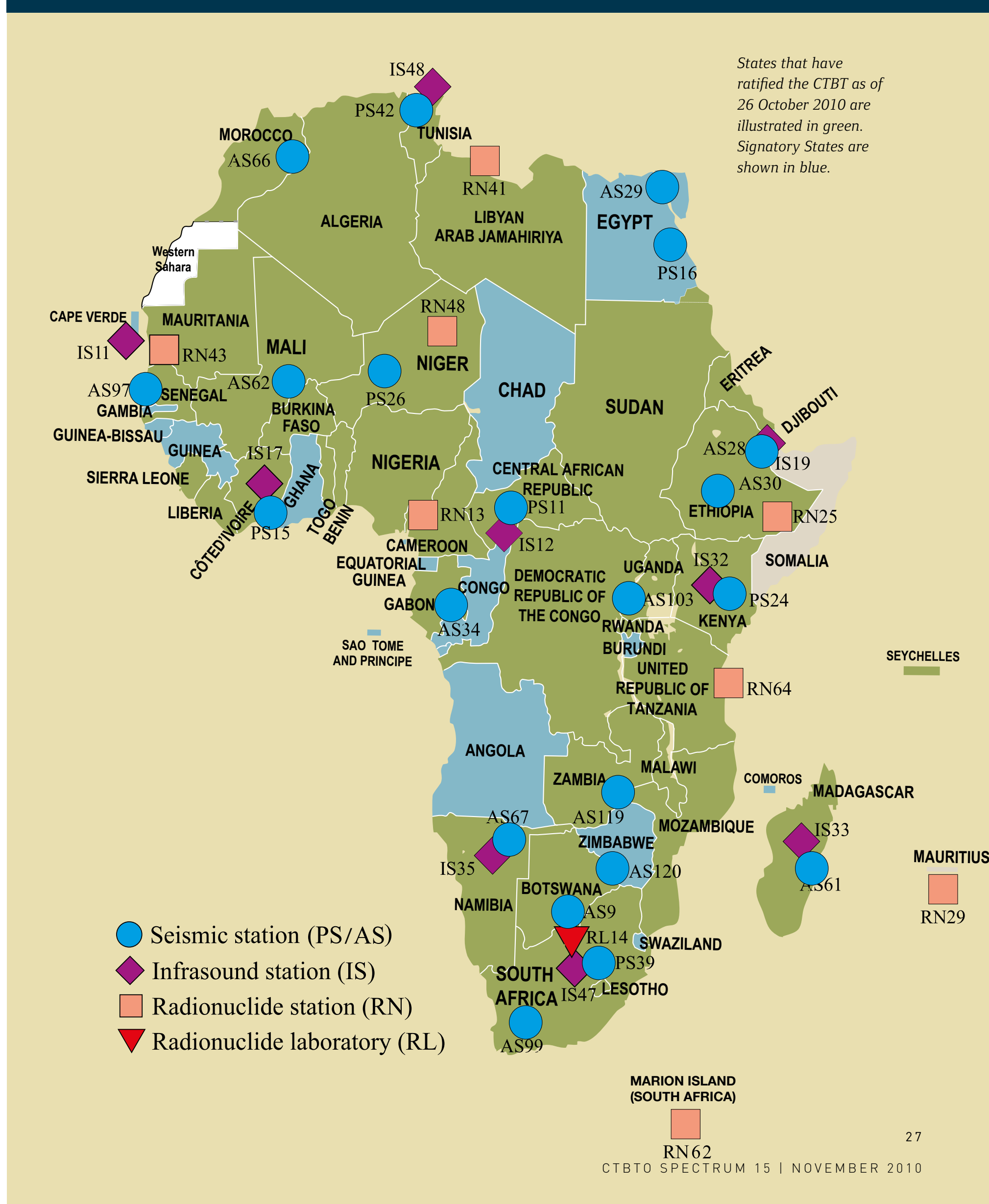
As a continent, Africa continues to face a number of development challenges such as poverty, disease, and political conflicts. In view of these pressing issues, how did you become aware of the importance of ratifying the CTBT?

Many of the development challenges confronting Africa can be attributed to the military/political wars in the region and other parts of the world.

The CAR is a vast territory covering an area of 623,000 km² with a population of only four and a half million. The country is extremely rich in natural resources (diamonds, cobalt, gold, iron, oil, uranium etc.) So one might ask why my country is facing development challenges. Over the years, a number of political conflicts have destroyed the economy, generating unemployment. The CAR is currently ranked among the poorest countries in the world, with a high prevalence of HIV/AIDS compared to many other countries.

Since these factors greatly inhibit development, it is time to propose solutions to these problems. I realized that one such solution would be ratification of the CTBT, which is, in my opinion, one guarantor of international security and peace.

MAP OF AFRICA INDICATING ALL IMS FACILITIES PLANNED FOR THE CONTINENT



[1] Primary seismic stations send data continuously in real time to the International Data Centre in Vienna.

»As a full member of the CTBTO, the CAR will now benefit from accessing IDC products.«

The CAR needs security and peace to ensure the sustainable use of its natural resources mentioned above, and especially uranium from Bakouma in the east of the country. We all know that uranium is a raw material with two main applications: for military purposes, whereby it is used to make nuclear weapons, which can cause mass destruction, and for peaceful purposes, where uranium is used to fuel nuclear power plants. Of particular concern is the fact that uranium ore could be stolen by terrorists to make nuclear bombs.

When I realized the great danger posed by nuclear weapons, I became aware of the importance of ratifying the CTBT. By establishing a global network of monitoring stations, the CTBTO is helping to make the world a safer place by ensuring that no nuclear explosion goes undetected. I therefore felt that it was in my country's interests to proceed with ratification as quickly as possible. Another incentive to ratify were the advantages offered to CTBTO Member States that host IMS facilities, as described above.

The commitment of African States to the CTBT was also supported by the entry into force of the Treaty of Pelindaba in July 2009, which turned the African continent into a nuclear-weapon-free zone. Based on your personal experience, what do you think would be the most effective way to encourage the remaining 15 States in Africa that have not yet ratified the CTBT to do so? What can they learn from the example of the Central African Republic?

As I explained, it requires willingness, perseverance, and a commitment to succeed in order to achieve CTBT ratification.

With regard to the 15 countries in Africa that have not yet ratified the CTBT, I think that there is sometimes a lack of information and communication about the merits of the CTBTO's activities. To my knowledge, many people including some politicians in Africa and various other countries in the world, misunderstand or ignore the importance of ratification. For some, it is not ignorance, but can be attributed to other factors. The training that I received from the CTBTO meant that I was responsible for all CTBT-related information, allowing me to follow the organization's activities constantly and discuss the CTBT with the relevant authorities. After several years of information campaigns and sensitization about the Treaty, I succeeded in obtaining the support and commitment of the State Minister of Mines, Energy and Hydraulics, who was able to convey the message to policy makers in our country.

However, had I not acquired the necessary technical expertise, it would have been hard for me to convince the CAR authorities about the benefits of ratification. If this is also the case in the remaining 15 African countries, I think it would be desirable for CTBTO staff to carry out awareness-raising missions among the relevant authorities by meeting with Heads of State and National Assemblies in each country to discuss the importance of ratification.

I think and hope that this could accelerate the process of CTBT ratification by these 15 African States and would further strengthen the commitment of the continent to the Treaty of Pelindaba. I appeal to the authorities of the 15 outstanding African countries to ratify the CTBT as soon as possible to strengthen security

Mount Nyamulagira in neighbouring Democratic Republic of Congo erupted on 2 January 2010. Credits: RMCA - B. Smets.

and peace on the African continent, and, in particular, to accelerate the process of the CTBT's entry into force, making the world a safer place.

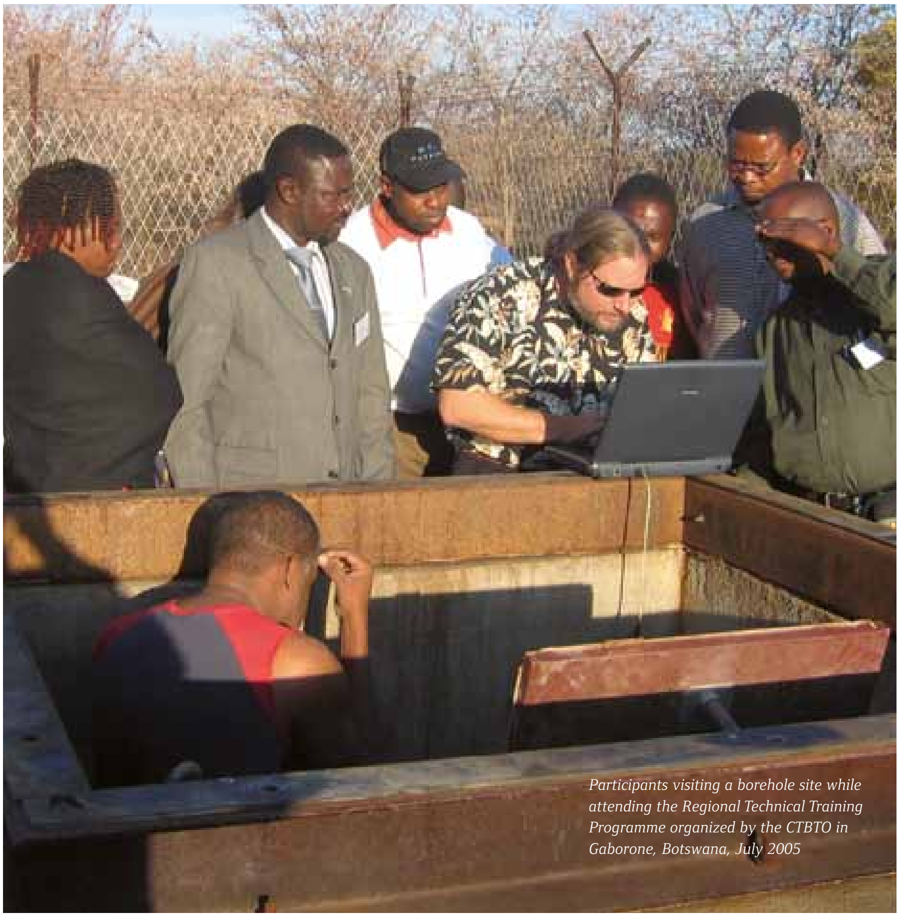
Between 2004 and 2010, you participated in several CTBTO training programmes. What knowledge have you acquired through your participation and how have you been able to share your skills with your colleagues in the Central African Republic?

In March 2004 and March 2007, I participated in Training Programmes for Station Operators and National Data Centre (NDC) Managers at the International Data Centre (IDC) in Vienna. In July 2005, I attended a Regional Technical Training Programme organized by the CTBTO in Gaborone, Botswana. Most recently in May 2010, I took part in a Technical Training Programme on the four scientific methods employed by the IMS.

These CTBTO training activities have helped me to gain knowledge in the following areas:

1. The history of nuclear testing since 1945
2. The Treaty and the objectives of the CTBTO
3. The role of the IDC and the four verification technologies employed by the IMS (seismic, hydroacoustic, infrasound and radionuclide monitoring)
4. How to maintain IMS stations and ensure their sustainability
5. The Global Communications Infrastructure and the transmission of data from IMS stations to the IDC
6. On-site inspections
7. Membership benefits for CTBTO Members States

This knowledge has enabled me to talk about the CTBTO to my relatives, friends, and some of my law professors at the University of Bangui. I sent letters with relevant information to certain authorities in the country, met with them, and eventually shared this knowledge with my colleagues in the Department of Mines, Energy and Hydraulics. In this way, we were able to achieve CTBT ratification.



Participants visiting a borehole site while attending the Regional Technical Training Programme organized by the CTBTO in Gaborone, Botswana, July 2005

Would the application of verification data be useful for the Central African Republic in terms of, for example, helping to improve aviation safety by detecting volcanic explosions, and contributing to climate change research?

The Central African Republic, like the rest of the world, strives for security and peace at the national, sub regional, regional and international level. To ensure development, my country needs to be secure. The advanced technologies and scientific methods employed by the CTBTO to monitor the planet for nuclear explosions are very important and beneficial for the CAR. My country is also concerned about earthquakes, climate change, and aviation safety problems caused by volcanic ash. The CAR is privileged to be situated in the heart of Africa and is keen to provide reliable data for the detection of natural disasters from the IMS station it hosts, through its National Data Centre in Bangui to the IDC in Vienna.

As a full member of the CTBTO, the CAR will now benefit from the advantages offered by the CTBTO in terms of accessing IDC products. There are a number of potential civil and scientific applications of the monitoring data such as enhancing the knowledge, capacities, and well-being of the population, and promoting the country's sustainable development.

FOR MORE INFORMATION ABOUT CTBTO TRAINING ACTIVITIES PLEASE GO TO WWW.CTBTO.ORG.

BIOGRAPHICAL NOTE

MICHEL NAMBOBONA is the first appointed Director General of the new National Data Centre of Bangui, which was created on 24 July 2010. Prior to this, he was Director of Electricity and Hydrocarbons and Deputy Coordinator of the National Agency for Radiation Protection at the Ministry of Mines, Energy and Hydraulics. An engineering geologist by profession, Dr Nambobona was in charge of the seismic station at the Geophysical Observatory of Bangui from 1994 to 2008.

A unique global network
that detects very low frequency sound waves in the atmosphere

BY PIERRICK MIALLE, NICOLAS BRACHET,
DAVID BROWN, PAULINA BITTNER,
JOHN COYNE AND JEFF GIVEN

This article describes the experiences gained by the infrasound network, part of the International Monitoring System (IMS), from the Sayarim Calibration Experiment in the Negev desert in Israel, as well as from collaboration with the Japanese National Data Centre (NDC-1). Both cases allowed the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) to test its equipment and detection capabilities. The article also explains how 15 IMS infrasound stations around the world recorded the meteoroid that exploded above Sulawesi, Indonesia, in October 2009, making it the largest event detected by the IMS infrasound network to date.

THE INFRASOUND NETWORK

When complete, the International Monitoring System (IMS) will comprise 337 facilities, including 60 infrasound stations. The infrasound network is unique in terms of the volume and the uniform distribution of its monitoring stations. Forty-two of the infrasound stations are already transmitting data continuously to the International Data Centre (IDC) in Vienna for processing and analysis.

The infrasound stations measure micropressure changes in the atmosphere generated by the propagation of infrasonic waves (low frequency sound). These waves are produced by a variety of natural sources such as exploding volcanoes, earthquakes, and meteors, as well as man-made sources, which include nuclear, mining and large chemical explosions etc.

With 70 percent of its stations fully operational, the infrasound network is able to register very large events at a number of stations around the globe. The recent extensive use of IMS infrasound data by the IDC has posed questions about the minimum size of an event (which may occur at any location) that can be detected by the IMS infrasound network. Questions also arise about the extent to which this minimum size varies over time due to constantly changing environmental conditions at the location. In order to address these questions, the CTBTO is participating in international infrasound experiments and is also collaborating with National Data Centres interested in advancing the infrasound technology used to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

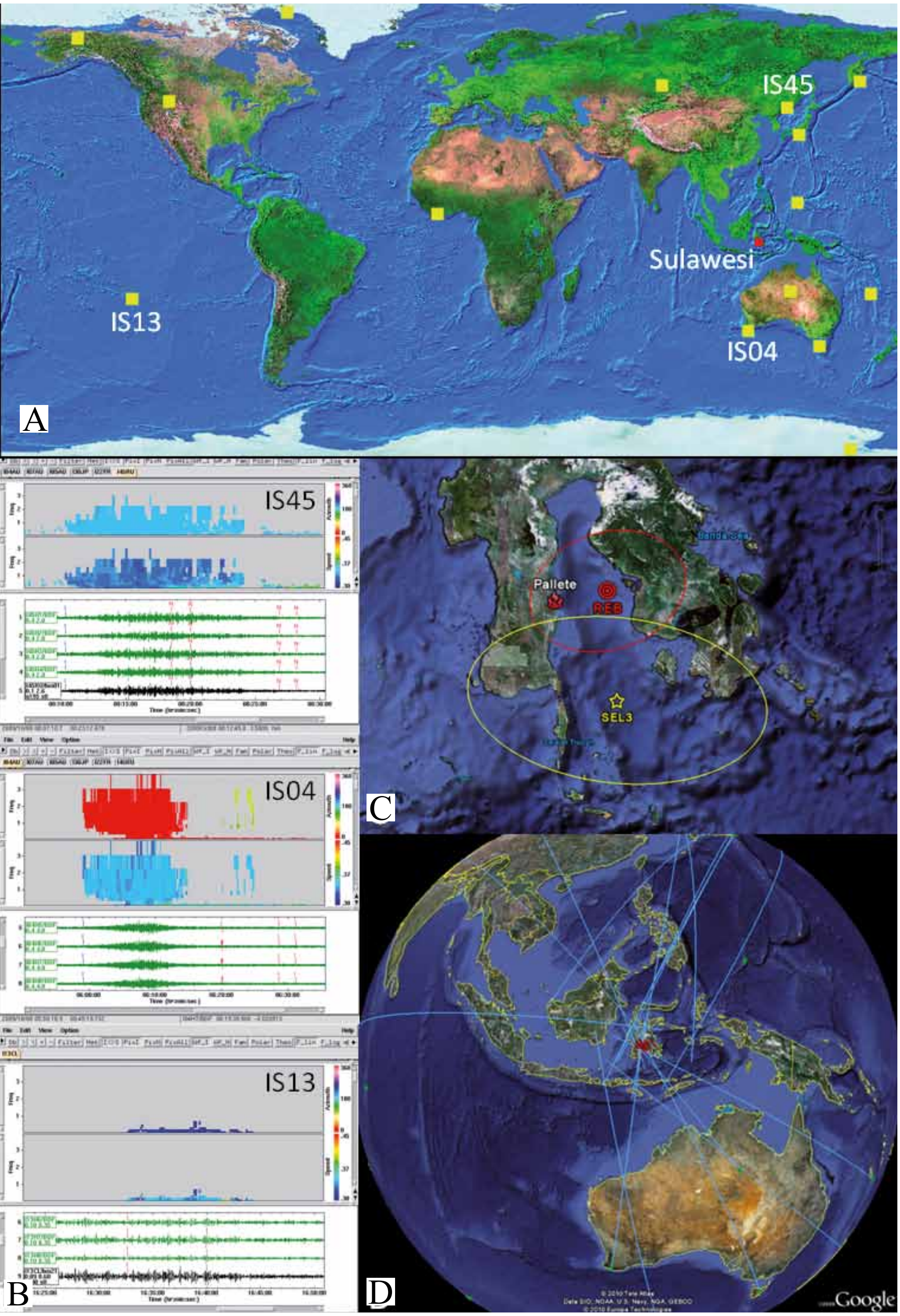
THE SULAWESI METEOROID

On 8 October 2009 at 02:58 UTC, a large meteoroid hit the Earth's atmosphere above South Sulawesi, Indonesia, and exploded. The only information came from local Indonesian authorities, who reported hearing a loud air blast up to 17 km from Pallete, Bone district, South Sulawesi, at around 03:00 UTC.

A couple of hours after the explosion, a number of IMS infrasound stations, which send monitoring data automatically to the IDC in Vienna, started recording infrasound waves from the blast. The IDC's automatic processing system recognized the data as originating from an acoustic disturbance in the Indonesian region.

EFFICIENT PERFORMANCE OF THE IDC'S AUTOMATIC PROCESSING SYSTEM

Based on assumptions about the source origin and infrasound propagation characteristics, the IDC scanned the IMS data interactively



FROM TOP LEFT TO BOTTOM RIGHT:

A) Map showing the Sulawesi event and the IMS infrasound stations that detected it (yellow).

B) Three examples of processing results: the upper two panels show the time versus frequency pixels with back-azimuths and trace velocity (the apparent speed at which the infrasound signal travelled across the array); the lower panel displays some of the filtered waveforms.

C) IDC automatic location and its error ellipse (in yellow), refined location and its ellipse (in red) and the village of Pallete.

D) Overview of the event location with the projected azimuth from all stations (green automatically associated, blue interactively associated).

and found 14 infrasound signal detections created by the automatic system and one manually detected related arrival. No related detection was found by the IMS seismic network.

The IDC's automatic system performed according to expectations by publishing an automatic bulletin that was interactively reviewed and refined by detections from stations up to 14,000 km – about three quarters of the way around the world – from the source. Considering the global distribution of stations involved, as well as the distance of detection and the signals' characteristics, the most probable source hypothesis was an exploding meteoroid, at high altitude, as indicated by local observations. As expected, most of the detections had stratospheric properties: stratospheric winds (about 50 km altitude) favour long-range infrasound propagation whereas thermospheric (about 100 km altitude) or tropospheric winds (around 10 km altitude) do not propagate over such large distances.

PROCESSING DATA AT THE IDC

Upon arrival at the IDC, the infrasound data from each station are processed automatically and independently using the Progressive Multi-Channel Correlation (PMCC) algorithm. PMCC estimates the signals' characteristics to determine whether the detections were infrasonic, seismic or spurious.[1]

Since an event may be recorded at more than one IMS station, the next step at the IDC is to determine which signals from different stations originated from the same source. All available detections are examined, eventually associated with an event, and then published in the IDC's automatic bulletins. A clearer picture of what actually occurred then begins to develop.

IDC analysts review the automatic bulletins and improve, correct or discard the events. The reviewed events are listed in timely and high quality Reviewed Event Bulletins (REB), which are made available to the Preparatory Commission for the Comprehensive Nuclear Test Ban Treaty Organization's (CTBTO) Member States.

REBs are produced using the three waveform technologies: seismic, hydroacoustic and infrasound. In February 2010, the IDC successfully reintroduced the routine analysis of infrasound data and events for inclusion in its daily products[2].

[1] For further reading, please see Brachet, N., Brown D., Le Bras R., Mialle P., and Coyne J. (2009). Monitoring the Earth Atmosphere with the Global IMS Infrasound Network. Chapter 3, *Infrasound monitoring for atmospheric studies*, Le Pichon A. et al. Published by Springer Science.

[2] Between 2004 and February 2010, the IDC redesigned the automatic infrasound system, introduced analyst procedures, and trained analysts with new infrasound review tools.

SAYARIM INFRASOUND CALIBRATION EXPERIMENT
A debris cloud rising high into the atmosphere above the Sayarim Military Range in the Negev desert, Israel, 26 August 2009. Photo courtesy of Dr Yefim Gitterman, Geophysical Institute of Israel

LARGEST EVENT EVER RECORDED BY INFRASOUND NETWORK

Once the infrasound waves were recorded at the more distant IMS infrasound stations, the final IDC event location was refined to about 45 km off the coast of Sulawesi in the Pallete region. The Sulawesi meteoroid is an interesting and, to date, unique case for infrasound automatic processing and interactive review because it presented such a high number of observations at IMS infrasound stations. This makes the event the largest recorded so far by the IMS infrasound network in terms of the number of stations and the distance of the observations.

THE SAYARIM INFRASOUND CALIBRATION EXPERIMENT

A large debris cloud rose high into the atmosphere above the Sayarim Military Range in the Negev desert, Israel, on 26 August 2009 at around 06:30 GMT. The cloud was the result of a large-scale calibration experiment carried out by the Geophysical Institute of Israel (GII) and sponsored by the U.S. Army Space and Missile Defense Command (SMDC). The experiment involved the upward detonation of about 82 tons of high-energy explosives.

The experiment aimed to:

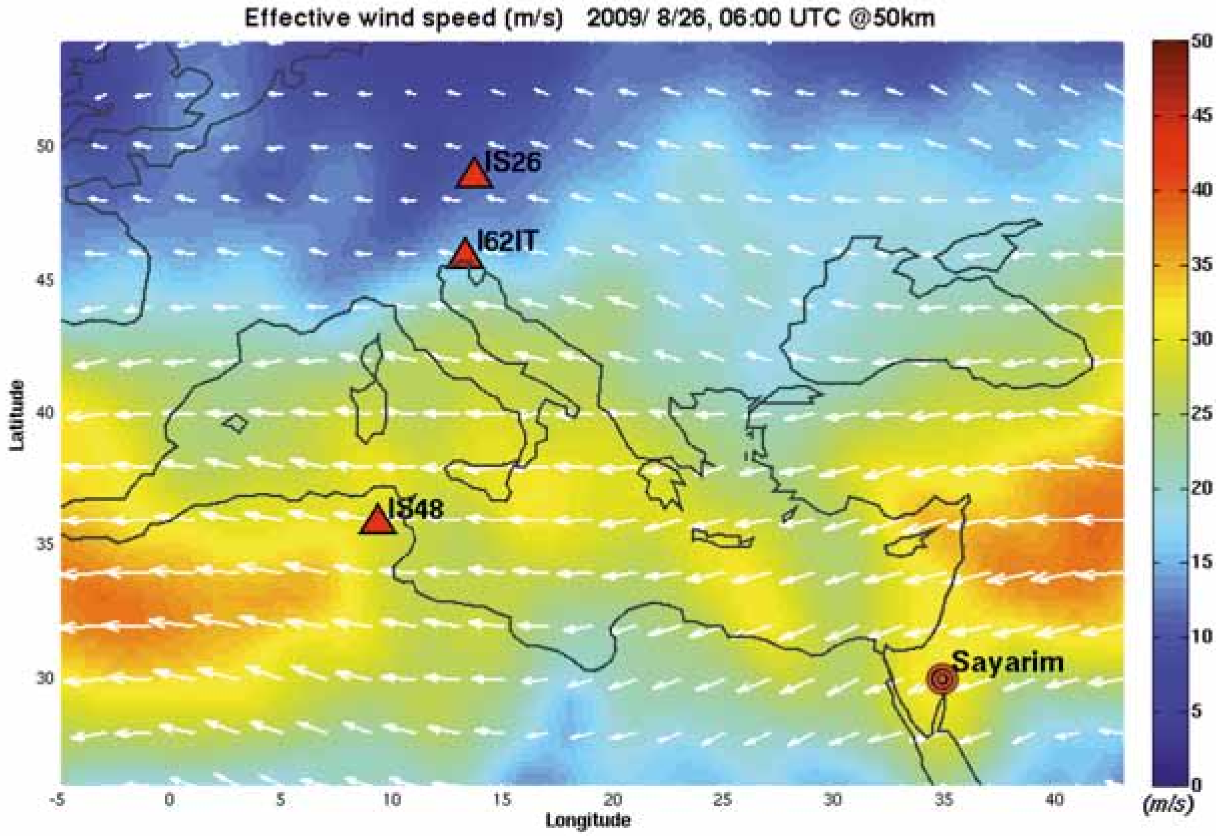
- Observe infrasound signals at a number of stations at distances up to 3,000 km from the explosion, thus establishing a Ground Truth infrasound dataset for the Eastern Mediterranean region
- Enhance the understanding of infrasound signals and propagation.

INFRASOUND DETECTION DEPENDENT ON REGIONAL WEATHER CONDITIONS

Since infrasound propagation is seasonally affected, the experiment was conducted in the summer when atmospheric conditions would be favourable for detections at IMS infrasound stations IS26 (Germany) and IS48 (Tunisia) as a result of the westerly stratospheric winds.

Numerous permanent infrasound arrays are installed in the Eastern Mediterranean region. Of particular interest for the CTBTO were the two stations IS26 and IS48, located closest to Sayarim. In order to achieve all of the experiment's objectives, technical and support teams from various institutes were also deployed to establish temporary infrasound arrays in Israel, Greece, Cyprus, Italy and France at distances of between 50 and 3,000 km from the detonation site. In addition to the permanent IMS infrasound arrays, the CTBTO set up its portable infrasound array, I62IT, in Friuli-Venezia, Italy. The site was selected to complement the IMS network and

The atmospheric model shows the stratospheric winds (at 50 km altitude) for the Euro-Mediterranean region on 26 August 2010 at 6:00 GMT. The model predicted a relatively strong eastward stratospheric wind. The IDC simulated the infrasound propagation using ray tracing software to evaluate and validate its simulation capacities. Meteorological data were provided by the European Centre for Medium-Range Weather Forecasts.



to provide knowledge on regional sources that might be observed in Germany and Tunisia.

MOST ENERGY FROM THE BLAST RELEASED INTO THE ATMOSPHERE

High-pressure values and strong ground motions were measured at distances up to 600 metres around the blast zone. A seismo-acoustic analysis of the explosion confirmed that most of the energy was released into the atmosphere and a minimum amount was transmitted to the ground.

The explosion was detected by the two regional IMS stations: IS26 (2750 km from Sayarim) and IS48 (2460 km away) as well as by I62IT (2560 km away).

EXPERIMENT OF GREAT INTEREST TO INFRASOUND COMMUNITY

The Sayarim calibration explosion was detected by several European arrays and temporary arrays located at ranges of between 300 and 3,500 km from the detonation site as well as by the two IMS infrasound stations. While no primary IMS seismic stations detected the explosion, further analysis showed that the local seismic network and an IMS auxiliary station picked up seismic arrivals.

The results of the experiment are of major interest to the infrasound community as they will be used for in-depth analysis and research. The experiment provides a unique Ground Truth infrasound dataset for the Eastern Mediterranean region during the summer.

COLLABORATION WITH JAPANESE NATIONAL DATA CENTRE (NDC-1)

The CTBTO attaches great importance to capacity building activities, particularly in terms of assisting National Data Centre (NDC) staff in the CTBT-related verification technologies.

An area of interest to many NDCs is the deployment of portable infrasound equipment. The CTBTO has recently collaborated with several NDCs in this field, offering NDC staff a range of opportunities. In addition to receiving CTBTO training in relevant hardware and software, participants improve their understanding of atmospheric propagation and help to validate regional atmospheric models. NDC staff also study regional and distant infrasound sources, which supports IDC routine analysis.

FOLLOW-UP ACTIVITIES PLANNED FOR 2011

An infrasound Ground Truth calibration experiment in the Eastern Mediterranean is scheduled for the beginning of 2011, with the following objectives:

- **Repeat the 2009 Sayarim experiment during a different season**
- **Test the infrasound propagation model**
- **Calibrate the yield measurement methods**
- **Cooperate with regional participants to identify and study additional infrasound sources in the region**

Location of Sayarim Military Range in Israel. IMS detecting stations IS26, (5 elements, Freyung, Germany), IS48 (8 elements, Kesra, Tunisia) and the CTBTO's portable array I62IT (4 elements, Strassoldo, Italy). Blue lines represent the back-azimuth extracted from the detected signals for each infrasound array.

In March 2010, the CTBTO embarked on a six-month project related to infrasound technology with the Japanese NDC-1[3], which comes under the responsibility of the Japan Weather Association (JWA).

As well as the overall goals outlined above, the project aimed to:

- Assess the impact of anthropogenic activity near IMS infrasound station IS30
- Estimate the performance of the CTBTO's portable infrasound array equipment, I64JP, in relation to IS30
- Train JWA staff on equipment operation and maintenance, and on the software used for infrasound data processing

The project took place at three different sites: in Tsukuba[4], which is about 60 km from Tokyo; in co-location with IS30 at Isumi in Western Japan; and at the University of Hokkaido in northern Japan.

INFRASOUND REFERENCE EVENT DATABASE

Significant infrasound events have been included in the IDC's Infrasound Reference Event Database (IRED) since 2004

Its objectives are to:

- **Collect, review and document infrasound events of special interest**
- **Archive the data for each event into database tables**
- **Use this resource for training, testing and validation purposes**

The database currently contains 750 infrasound events generated by natural or anthropogenic sources. The database is available to CTBTO authorized users (through IDC Services services@ctbto.org). An updated IRED was released in July 2010.

[3] The Government of Japan has designated the JWA and the Japan Atomic Energy Agency as the NDCs dealing with waveform (NDC-1) and radionuclide data (NDC-2).

[4] Tsukuba was the original location of IS30, as foreseen in Annex 1 to the Protocol of the Comprehensive Nuclear-Test-Ban Treaty.

Installation of CTBTO's portable array in Tsukuba, Japan, March 2010

The portable equipment performed well at all three locations and its performance was comparable with that of IS30 when the arrays were co-located. When deployed at Tsukuba, the detection capability of I64JP was unaffected by activities at the nearby refinery at Tokyo Bay, which have negatively impacted IS30's processing results. The results demonstrated the importance of using such portable equipment together with IMS permanent arrays to study and understand regional infrasound background activity. The data collected were especially valuable for IDC infrasound routine analysis.

The collaboration has proven mutually beneficial. JWA staff gained experience in the use of portable infrasound equipment and IDC software, as well as on the scientific aspects of infrasound propagation. The CTBTO obtained valuable feedback on the use of its software and on the usefulness of the portable infrasound array. Both sides have expressed a strong interest in continuing their cooperation in infrasound technology.

Acknowledgements:
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GLOSSARY

AZIMUTH:
A horizontal direction defined by an angle measured clockwise from true north. "Back-azimuth" involves reversing the bearing of the azimuth.

GROUND TRUTH:
Seismoacoustic sources whose location, depth and origin time (together with their uncertainties) are known to high precision, either from non-seismic evidence or using exceptionally good coverage of seismometers close to the event.

RAY TRACING:
Infrasonic ray tracing is a procedure whereby the most likely path of propagation that a sound wave takes is predicted based on assumed temperature and wind-speed profiles along the propagation path.

BIOGRAPHICAL NOTES

PIERRICK MIALLE
joined the CTBTO in 2008 and now works for the IDC as an Acoustic Officer. Prior to that, Dr Mialle worked for the Commissariat à l'énergie atomique (CEA) in France for four years on the atmospheric propagation of infrasound waves.

NICOLAS BRACHET
worked as Acoustic Officer at the IDC from 1998 to 2010. In August 2010, he rejoined the French National Data Centre at the Commissariat à L'Énergie Atomique (CEA) where Mr Brachet worked prior to the CTBTO in the fields of seismology and infrasound.

DAVID J. BROWN
has worked at the IDC as a Software Engineer since 2008. Prior to that, Dr Brown worked as an Infrasonic Scientist in the nuclear monitoring group at Geoscience Australia and with Science Applications International Corporation at the Prototype IDC in Arlington, Virginia, United States.

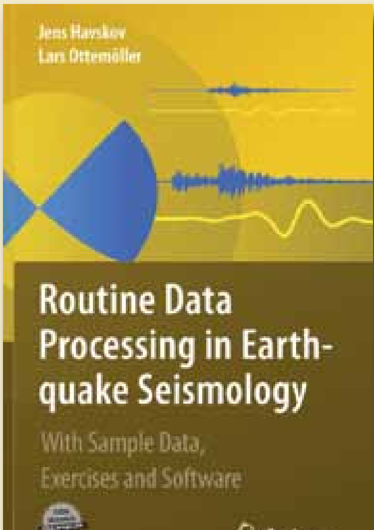
PAULINA BITTNER
worked at the IDC until Dec. 2009, latterly as Lead Analyst at the Monitoring and Data Analysis Section. Prior to this, Dr Bittner held an appointment at the Polish Naval Academy. She also worked at the Prototype IDC.

JOHN COYNE
has worked at the IDC since 1998, where he is currently the Programme and Project Coordinator for the IDC Division. Prior to this, Dr Coyne worked in nuclear monitoring for 10 years for a contractor in the United States.

JEFF GIVEN
joined the IDC in 2009 as Chief of the Software Applications Section. Dr Given has over 20 years experience supporting research and development for treaty monitoring for GSETT2, GSETT3*, the United States National Data Center, the Prototype IDC, and the IDC.

*Group of Scientific Experts Technical Test (GSETT): Technical experiments conducted by the Ad-hoc Group of Scientific Experts. This was done to test monitoring technologies and data analysis methods for the verification of a nuclear test ban. GSETT1 took place in 1984, GSETT2 in 1991, and GSETT3 in 1995.

BOOK REVIEW



Routine Data Processing in Earthquake Seismology: With Sample Data, Exercises and Software

Jens Havskov and Lars Ottemöller
Published by Springer in May 2010. 380 pages

The number of seismic stations has increased rapidly over recent years leading to an even greater increase in the amount of seismic data. The increase is partly due to the general change of recording and storing of continuous data, which requires more processing and the efficient organization of the data.

The purpose of this book is to provide a practical understanding of the most common processing techniques in earthquake seismology. The book deals with manual methods and computer assisted methods.

A number of topics are covered: Earth structure and seismic phases; instruments and waveform data; signal processing; earthquake location and magnitude; focal mechanism and seismogram modelling; array processing; and network operation.

This book is intended for everyone involved in processing earthquake data, both in the observatory routine and in connection with research.

For more information please see: http://www.springer.com/earth+sciences+and+geography/geophysics/book/978-90-481-8696-9

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