

# The New Zealand Herald

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Sunday January 09, 2005

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## National News

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### Devastating tsunami bomb viable, say experts

30.06.2000

By Eugene Bingham

Tsunami experts believe a bomb secretly tested off the coast of Auckland 50 years ago could be developed to devastating effect.

University of Waikato researchers believe a modern approach to the wartime idea tested off Whangaparaoa could produce waves up to 30m high.

Dr Willem de Lange, of the Department of Earth Sciences, said studies proved that while a single explosion was not necessarily effective, a series of explosions could have a significant impact.

"It's a bit like sliding backwards and forwards in a bath - the waves grow higher," Dr de Lange said yesterday.

He was responding to a Weekend Herald report of experiments at Whangaparaoa in 1944-45 to create a tidal wave bomb. The top-secret work by the late Professor Tom Leech was detailed in 53-year-old papers released by the Ministry of Foreign Affairs and Trade.

Dr de Lange said a coastal marine group from the university recently studied the likely impacts of underwater volcanic explosions.

Their work concluded that the next eruption in the Auckland region was likely to be under water, given the large amount of water around the city.

But tests showed a single explosion in the Hauraki Gulf would not trigger much of a tsunami.

"For most places the wave was less than 1m high, but it could be a bit more in the Tamaki Estuary."

Dr de Lange said the waves were not high because the energy was projected upwards, not sideways. He believed the same principle would be true for a tsunami bomb.

"You can't confine the energy. Once the explosion gets big enough, all of its energy goes into the atmosphere and not into the water. But one of the things we discovered was if you had a series of explosions in the same place, it's much more effective and can produce much bigger waves."

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AIR NEW

WEDNESDAY, JANUARY 12, 2005

B3

## Prof. cites bomb theory for tsunamis

FOR THE DAILY GLEANER

University of New Brunswick geographer Gary Whiteford, is raising questions concerning the recent tsunami disaster in the Indian Ocean.

The tsunami was triggered by a 9.0 magnitude earthquake that was centered off the northwestern Indonesian island of Sumatra. So far more than 150,000 people have perished from the catastrophe.

Whiteford has studied large magnitude earthquakes 5.8 or above and found that nuclear bomb testing can be linked to significant earthquakes. He presented his research paper in April 1989 to the Second International Conference on the United Nations and World Peace in Seattle, Washington.

He stated in his submission:

"In my opinion, bomb testing in the past triggered, within 5 days, earthquakes of a magnitude 5.8 and above that directly killed over 2 million people. Some people feel that linking nuclear bomb testing to earthquakes is pure coincidence. One U.S. geologist felt that even just the idea itself is witchcraft and akin to astrology."

The UNB professor is concerned that perhaps secret nuclear bomb tests have been conducted despite the signing of the Comprehensive Test Ban Treaty in September 1996. As of 2002, 165 countries have signed this treaty.

The problem is how to verify nuclear bomb tests and who does the verification, says Whiteford

The UNB professor wonders if it is the International Monitoring System (IMS). He says that the U.S. Department of Energy announced in the late 1980s that 204 of their 925 nuclear bomb tests at the Nevada test site were not announced at the time these occurred.

"Where was the IMF? Who exactly is watching for and monitoring these tests?" asked Whiteford. "We know both India and Pakistan tested some 10 times in May 1998, even after the Comprehensive Test Ban Treaty was implemented."

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FREDERICTON, NEW BRUNSWICK

Whiteford is concerned that there is no proper verification in place regarding unannounced nuclear bomb tests or tests of a sub-critical nature. Besides the India and Pakistan tests in 1998, both China in 1996 and the French in Polynesia in 1995 conducted tests.

Whiteford urges a full analysis of linking nuclear bomb testing in the 1990s to earthquakes. He claims there is a difference between naturally occurring earthquakes and nuclear earthquakes.

He says the International Monitoring System (IMS) needs to inform the world who is really monitoring and report openly on all nuclear bomb tests.

According to Whiteford, the world should be demanding answers as to just who is testing these nuclear bombs, and where and when.

## The Daily Gleaner ONLINE



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# NUCLEAR BOMB TESTS:

## A DANGEROUS ENVIRONMENTAL MESS

▼ GARY T. WHITEFORD

*If nuclear testing continues, blasts could become bigger and bigger; the horrendous environmental and human consequences of nuclear bomb testing remain largely hidden, however.*

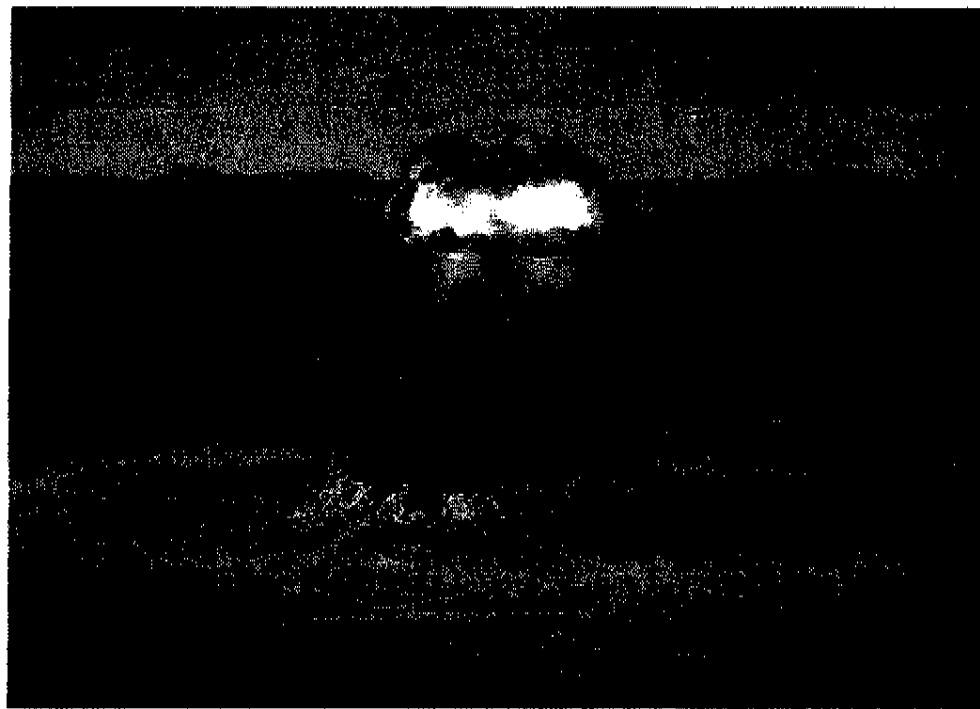
The first nuclear bomb was detonated on July 16, 1945, in New Mexico. Next came the bombs dropped on Hiroshima and Nagasaki. Over 2,100 nuclear bombs have been detonated since 1945, but there is hope that the world has seen the end of this bomb testing. Last year, the United States continued its moratorium on nuclear testing; only China violated the ban in October. The next big hurdle is whether the major powers will renew the Nuclear Non-Proliferation Treaty set for review in April 1995.

Our planet faces major environmental threats. Many people who are familiar with ozone depletion, acid rain, or toxic wastes remain virtually ignorant of the frequency of nuclear testing. Few scientists speak out against this most deliberate crime against the environment known to humankind. The United States, Russia, and France conduct frequent tests; Britain and China generally conduct one or two tests each per year.



Dr. Whiteford has taught geography at the University of New Brunswick in Fredericton since 1974. A member of the National Council for Geographic Education and the Canadian Association of Geographers, he has written a number of articles on geography and environmental issues and co-edited an acclaimed atlas of the world.

During the 1980s, there were about 50 tests per year. The United States, Russia, and France are currently observing a moratorium on nuclear tests; President Bill Clinton announced that he will observe the moratorium through September 1994. Soviet leaders have long sought a permanent test ban. From July 1985 to February 1987, the Soviets imposed a unilateral moratorium, hoping that the United States would



follow suit, but the United States conducted 26 nuclear bomb tests during the halt. There has been only one nuclear test in the former Soviet Union during the past four years; no doubt all testing worldwide would stop if the United States extended its moratorium indefinitely.

By international agreement, all tests are underground and are not to exceed 150 kilotons; in May 1992, however, China set off the largest underground nuclear bomb test it has ever conducted — a one-megaton blast, far exceeding the limit observed by Washington and Moscow. Further, China defied the current international moratorium last October by exploding a nuclear bomb between 10 and 90 kilotons. (The Hiroshima bomb, by comparison, was about 20 kilotons.) The largest underground bomb test was a 1971 American five-megaton blast; the largest atmospheric test was a 1961 58-megaton Soviet explosion. (A megaton is 1,000 kilotons.) Observers see these latest Chinese tests as setting a new and dangerous precedent not bound by any international treaty. Will this frightening new trend become the norm? New players in this deadly game — North Korea and Pakistan — are emerging.

### Scarring the landscape

U.S. bomb tests are conducted just north of Las Vegas, Nevada. Since 1945, over

1,000 tests have occurred on land that the western Shoshone Indians claim as the sacred grounds. The cost of U.S. nuclear bomb test programs has increased from some \$240 million a year in 1980 to \$1 billion a year today. There are two types of tests: tests of the weapons themselves, and tests of the effects of nuclear explosives on other military weapons and equipment. About 80 per cent of U.S. tests fall into the first category.

The Nevada test site is also used by the British, who have conducted about 25 underground tests since 1962. Nuclear tests are conducted in shafts drilled as deep as a mile into the earth. Each test releases tremendous force, carving out a high cavern filled with high-pressure hot gases. As these gases cool, the pressure drops and the earth caves in, creating giant craters that permanently scar the desert landscape. Frequently, radioactive gases are released into the atmosphere. The blast contaminates groundwater as well as fracturing bedrock and mesas. Radioactive waste produced by testing is unsafe for up to half a million years. There are no safe containment methods.

Opposition to nuclear testing began in the 1950s with concern about radioactive fall-out resulting from atmospheric testing. In 1963, the Americans and Soviets finally agreed to conduct only underground tests

France did not agree until 1975. The deaths of some 6,000 sheep in southern Utah, just northeast of the test site, may have alerted researchers to the dangers of above-ground testing. The U.S. government maintained that it was just bad vegetation that killed the sheep.

In December 1993, the Clinton administration disclosed that the United States had conducted 204 secret underground nuclear bomb tests that were never made public. Eighteen such unannounced tests were conducted during the Reagan and Bush administrations, the most recent in April 1990. To date, this is only part of the hidden story that has emerged from a 32-million-page mountain of secret documents waiting to be declassified. It is clear that few precautions were taken to protect either official observers or civilians living near the Las Vegas test range. We must surely wonder whether the truth about this deadly business of nuclear bomb testing will ever emerge.

The Lawrence Livermore National Laboratory of California concluded that above-ground testing of massive nuclear warheads during the 1950s and early 1960s seriously damaged the ozone layer. Scientists found that detonation of nuclear bombs caused a 5-per-cent ozone loss over the central United States and a 12-per-cent ozone loss over the Arctic. The bomb explosions lofted atomic fireballs into the stratosphere, and the intense heat produced short-lived nitrogen ions, which initiated a catalytic cycle splitting ozone into oxygen and nitrogen oxides. Despite the testing going underground, there is still steam and "dynamic venting" and possible fissure eruptions after every nuclear bomb test. What are the long-term environmental consequences of these dangerous side effects?

### Nuclear testing and earthquakes

Another environmental concern about the bomb tests in the United States, and all tests for that matter, is the earthquakes generated by the explosive force unleashed. The U.S. Department of Energy, which is responsible for the tests, always issues advance warnings of tests. Las Vegas are asked to take extra care when working in highrise buildings or on outside scaffolds. After any given test, buildings can be felt to sway.

There is concern about changes in the

naturally occurring earthquake.

A U.S. bomb test on June 23, 1992, was followed by two unprecedented major earthquakes (7.4 and 6.5 Richter readings) in southern California only five days later. There have been many such "coincidences" over the almost 50 years of testing. The largest number of deaths from an earthquake this century (800,000) occurred as a result of an 8.2 magnitude earthquake in Tangshan, China on July 28, 1976, the day after a U.S. test. The Armenian earthquake (6.8 on the Richter scale) that killed 60,000 people on December 7, 1988, came three days after a Soviet bomb test on the island of Novaya Zemlya, north of the Arctic Circle.

Most Soviet tests have occurred at two main sites. Fifty per cent have taken place near Semipalatinsk in eastern Kazakhstan, with another 20 per cent detonated on Novaya Zemlya. The Soviets have tested over 600 times since their first nuclear explosion in 1949. Recently, grass-roots popular pressure finally stopped nuclear testing at the Semipalatinsk site. This action forced the government to move all tests to the ecologically fragile Arctic site of Novaya Zemlya.

If the moratorium is allowed to expire, the Soviets will again use the pristine Arctic region for further nuclear pollution. Russia estimates that at least 1 billion curies of radiation have gone into the high Arctic, mostly from nuclear weapons tests and waste disposal. (A curie is a unit of radioactivity.) By contrast, the 1986 Chernobyl accident released 40 to 86 million curies.

No large-magnitude earthquakes were recorded in Novaya Zemlya between 1900 and 1950, but since nuclear testing began there, six earthquakes measuring 5.8 or higher on the Richter Scale have been registered.

### Plutonium in paradise

The French test site, the only nuclear test site south of the equator, is located very close to the Tropic of Capricorn, at 23° 30' south latitude. The French have exploded some 200 nuclear bombs since 1960, about eight a year recently. In the last 10 years, French bombs have accounted for about 20 per cent of all nuclear bombs exploded worldwide.

One observer has described this setting as "plutonium in paradise." Testing has

ing program due to the continued opposition expressed by virtually all Pacific nations. The French bombing of the Greenpeace protest ship *Rainbow Warrior* in July 1985 shows the lengths to which France will go to maintain secrecy.

Unlike other nuclear bomb sites, the French location can be devastated by cyclones, which means that radioactive con-

### TOTAL NUCLEAR EXPLOSIONS 1945 - 1992

YEAR	USA	USSR	FRANCE	UK	CHINA	YEARLY TOTAL
1945	3					3
1946	2					2
1947	0					0
1948	3					3
1949	0	1				1
1950	0	0				0
1951	16	2				18
1952	10	0		1		11
1953	11	4		2		17
1954	6	7		0		13
1955	18	5		0		23
1956	18	9		6		33
1957	32	15		7		54
1958	77	29		5		111
1959	0	0		0		0
1960	0	0	3	0		3
1961	10	50	2	0		62
1962	96	44	1	2		143
1963	44	0	3	0		47
1964	38	6	3	1	1	49
1965	36	10	4	1	1	52
1966	43	15	7	0	2	68
1967	34	17	3	0	2	56
1968	45	15	5	0	1	66
1969	38	16	0	0	2	56
1970	35	17	0	0	1	53
1971	17	19	6	0	1	43
1972	18	22	3	0	2	45
1973	16	14	5	0	1	36
1974	14	18	8	1	1	42
1975	20	15	2	0	1	38
1976	18	17	4	1	4	44
1977	19	18	6	0	1	44
1978	17	27	8	2	3	57
1979	15	29	9	1	1	55
1980	14	21	13	3	1	52
1981	16	22	17	1	0	56
1982	18	32	6	1	1	58
1983	17	27	9	1	2	56
1984	17	29	8	2	2	58
1985	17	9	8	1	0	35
1986	14	0	8	0	0	23
1987	14	23	8	1	1	47
1988	14	17	3	0	1	40
1989	11	7	8	1	0	27
1990	8	1	0	1	2	18
1991	7	0	6	1	0	14
1992	6	0	0	0	2	8

predictably contained. Between 1980 and 1983, six cyclones severely damaged Mururoa, but a wall of silence meets all inquiries about environmental conditions. The best guess is that all lethal material, whether in metal drums or in plastic containers, is simply swept out into the ocean, in some cases moving on to the other nearby islands. The French do not appear to have taken safety precautions to prevent further dispersal of radioactive materials due to cyclones. Since 1983, they have simply scheduled all tests outside the cyclone season.

Venting, leakage, and seepage regularly accompany French nuclear tests. Mururoa is like a radioactive sponge, constantly contaminating the surrounding waters. Sometimes nuclear detonations can produce unexpected tidal waves, as occurred in July 1979. Research suggests that the fracture of coral rock allows radioactive materials to leak to the surface in tens of years, rather than the 1,000 years estimated by the French.

#### The medical consequences of testing

Sadly, the medical consequences of any radioactive release for the island people — past, present, or future — may never be known. There are claims of rising rates of thyroid cancers, brain tumours, and leukemia, all of which can be radiation-induced, but hard statistics are not available. A registry for tracking cancer rates was not established until the early 1980s.

Despite 30 years of determined struggle for independence by the indigenous peoples, all important decisions in Polynesia are made by the French government. The 130 islands of French Polynesia are scattered over an area of the South Pacific the size of Europe. The French ignore any opposition to nuclear tests, steadfastly refuse to release any health statistics, and prevent independent health surveys. Nothing is likely to change. The site is so difficult to reach or even find on a map that there is little chance of eliminating nuclear bomb testing in this area.

The Chinese test site is at Lop Nor in the northwestern Xinjiang region, situated at 41°N, 88°E. Some 40 nuclear bombs, 16 of which were atmospheric, have been exploded. Lately, little regard has been shown for the 150-kiloton limit. The Chinese have averaged one or two nuclear tests a year in recent times.

Xinjiang is inhabited by native Uighur people, as well as Kazakhs and Mongolians.

▼ ▼ ▼

## **The next big hurdle is whether the major powers will renew the Nuclear Non-Proliferation Treaty set for review in April 1995.**

▼

strations in Western China and Beijing to protest against nuclear testing. Chinese authorities deal harshly with any opposition, as shown by the Tiananmen Square massacre. Information is scant about the health and environmental effects of Chinese testing and public resistance. Interestingly, the Chinese one-megaton nuclear test in May 1992 was first thought by scientists to be an earthquake.

#### Protests fall on deaf ears

No nation in the world is more familiar with the utter horror of nuclear bombs than Japan. After each nuclear test,

the mayors of both Hiroshima and Nagasaki send letters pleading for all nuclear bomb tests to cease forever, but their persistent pleas fall on consistently deaf ears. Some 360,000 Hibakusha or atom-bomb survivors are still living in Japan and still suffering the after-effects of the two 1945 bombings.

Nuclear test sites have surely contaminated thousands of workers and residents alike, but this information remains hidden as well. For example, it was reported in 1992 that a 1979 Soviet nuclear bomb test occurred next to a Ukrainian coal mine. Next day, thousands of miners were sent back to the adjoining mine shaft without

was the latest disclosure by the Clinton administration of America's nuclear secrets, including the use of human guinea pigs injected with plutonium.

#### Will it ever end?

Surely by now, after over 2,100 test whatever was to be learned from exploding a nuclear bomb has been learned. Why, in light of the current thaw in East-West relations, does the question of testing still remain? It would be sad to think that the large number of people involved in detonating and monitoring these tests are constant lobbying for the continuation of testing for fear of losing their jobs. A government bureaucracy is clearly involved.

Can the present moratorium not be extended forever? If not, the environmental consequences for this planet are grave indeed. It is expected that there will be few tests but larger bombs, well beyond the 150 kiloton range. This has happened before and the Chinese, for one, have set their own limits.

Nuclear testing will continue with as little publicity as possible. The less the public is aware of the testing, the greater the likelihood that testing will continue without question or protest. Perhaps the born "they" want is one that destroys humans but leaves buildings and other structures like bridges still standing. Whatever the ultimate purpose behind all these tests, we may all find out within the next few years — but millions may not live to tell about it. ■

#### SUMMARY

*Of all the environmental crimes that humankind has committed, surely nuclear bomb testing is the most diabolical. It is unnecessary, easy to terminate, and perpetuated by the most wealthy and educated powers. This is one crime that cannot be flung at the doorstep of the Third World.*

*Nuclear bomb tests have continued without serious debate for almost 50 years, with little public notice or scrutiny. There have been over 2,100 tests since the Hiroshima bomb was dropped in 1945. Currently, the United States, Russia, and France are observing a moratorium, but China has violated past and present moratoriums with seeming impunity. All of this points to the pressing need to renew the Nuclear Non-Proliferation Treaty set for review in April 1995.*

*Nuclear test sites remain unfit for human habitation. Over the past 50 years, numerous "coincidental" earthquakes have been set off by the explosive force unleashed in nuclear testing. Yet protests against testing continue to fall on deaf ears.*

*Surely by now, after over 2,100 nuclear bomb tests, whatever was to be learned has been learned. Why does the question of testing remain for debate? Perhaps the ultimate bomb would be one that destroys humans, leaving buildings and other structures still standing.*

#### RÉSUMÉ

*De tous les crimes contre l'environnement commis par l'humanité, les essais tactiques nucléaires sont assurément les plus diaboliques. Ils sont superflus, faciles à éliminer, et perpétrés par les puissances les plus riches et les mieux éduquées. Voilà bien un crime qui ne peut pas être balayé à la porte du Tiers-Monde.*

*L'essai de bombes nucléaires s'est fait pendant presque cinquante ans sans grand examen ou avis publics. Plus de 2100 essais ont été effectués depuis le lancement de la bombe sur Hiroshima en 1945. Alors qu'aujourd'hui les États-Unis, la Russie et la France respectent un moratorium à cet effet, la Chine continue à violer celui-ci, comme ceux d'hier, en toute impunité. Toutes ces raisons militent de façon pressante pour la renégociation du Traité de non-prolifération nucléaire dont la révision est prévue pour avril 1995.*

*Les sites d'essais nucléaires demeurent impropres à l'occupation humaine. Au cours des cinquante dernières années, de nombreux tremblements de terre, considérés comme de simples «coïncidences», ont été provoqués par la force explosive libérée suite à ces essais. On continue pourtant à faire la sourde oreille à leurs protestations.*

*Après maintenant plus de 2100 essais tactiques nucléaires, ce qu'on voulait apprendre est sûrement appris. Pourquoi faut-il toujours débattre de la question des tests? La bombe ultime devrait sans doute détruire tous les humains pour ne laisser que les édifices et les structures sur pied.*

# DOE

# FACTS

## DECLASSIFICATION OF UNANNOUNCED NUCLEAR TESTS AT THE NEVADA TEST SITE

The Department of Energy has declassified the total number of tests conducted at the Nevada Test Site including all previously unannounced tests. Nuclear weapon tests are defined by the Threshold Test Ban Treaty as follows:

- The term "underground nuclear weapon test," hereinafter "test," means either a single underground nuclear explosion conducted at a test site, or two or more underground nuclear explosions conducted at a test site within an area delineated by a circle having a diameter of two kilometers and conducted within a total period of time of 0.1 second. The yield of a test is the aggregate yield of all explosions in the test.
- The term "explosion" means the release of nuclear energy from an explosive canister.
- The term "explosive canister" means, with respect to every explosion, the container or covering for one or more nuclear explosives.

### SPECIFICALLY:

- There were 925 nuclear tests at the Nevada Test Site of which 204 were previously unannounced.
- The total number of tests conducted by the U.S. worldwide is 1,051.
- These tests include a number of locations other than the Nevada Test Site which were previously announced; e.g., other sites in the United States as well as in the Pacific and Atlantic Oceans.
- Additional aspects related to these tests such as specific yields, number of devices, etc., will be reviewed for future release and further review will be carried out to refine the accuracy of the historical test information.

(MORE)

U.S. Department of Energy  
Office of Public Affairs  
Contact: Sam Grizzle  
(202) 586-5806

## CBC Radio News Report, October 10, 1996

A weapons project that is stranger than fiction. A Moscow newspaper reports that Russian scientists tried to harness earthquakes as a weapon of mass destruction and the research continued under the new Russian government long after the Soviet Union collapsed. Our Moscow <sup>r</sup>correspondent, Mike Hornbrook, has the story:

The Moscow News calls it "Earthquakes Made To Order." In a detailed article the newspaper says research on a so-called tectonic weapon began under the Communists in the 1970's. By late 1987 the Soviet government ordered a major effort to develop such a weapon. It was code named Project Mercury and Project Vulcan, and involved almost two dozen scientific and manufacturing centres. The theory was that underground nuclear explosions could trigger earthquakes far from the site of the original blast. Researchers speculated that the destructive force released would be many times greater than the nuclear blast, that it could be directed at any point on the earth, and that there was no way to guard against it. According to the Moscow News, everyone involved with the project had the highest security clearance. The first underground nuclear test was carried out six years ago, possibly followed by two more blasts as the pace of research picked up. The newspaper says Boris Yeltsin's government continued the work until two or three years ago. At that time a crisis in the Russian economy put everything on hold. However, the Moscow News says that Russia's strategic military doctrine now includes a secret protocol on tectonic weapons. Western experts are said to be astounded that such a weapons program was ever attempted. Many believe the notion of triggering and controlling earthquakes is pure science fiction.

Mike Hornbrook, CBC News, Moscow

This radio news report was aired on October 10, 1996 at 7:00 a.m. ADT on CBC National News broadcast on local CBC radio station CBZ, 970AM on the radio dial. The station is located in Fredericton, New Brunswick, Canada.

**RUSSIA****Five Nuclear Tests Skirt Ban Treaty**

MOSCOW — Russia conducted five nuclear tests of a sub-critical level at an Arctic testing range this fall, a top official said Thursday, contradicting previous denials.

Such tests are not prohibited by the Comprehensive Test Ban Treaty because the amount of radioactive plutonium used is not enough to create a nuclear explosion. But critics say carrying out even limited tests could encourage other countries to conduct full-scale nuclear tests.

Deputy Nuclear Energy Minister Lev Ryabev said the tests on the Arctic archipelago of Novaya Zemlya were conducted between Sept. 14 and Dec. 13, the Interfax news agency reported.

Western news reports claimed in September that Russia was preparing a sub-critical nuclear test on Novaya Zemlya.

But Moscow denied the reports in October, after they had already begun, according to Ryabev.

25 Dec 1998

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**Geology****Seismic Ears for Nuclear Peace**

**Seismology is a keystone of the world's effort to monitor nuclear weapons tests.**

Atomic warfare started with two bombs in the summer of 1945. In the decades since then, thousands of nuclear explosives have been tested.

**About.com** has a map on the Web that shows where the bombs were deployed and who exploded them: the dots scattered around the world's remote places look no different from the two dots in populated southern Japan. And for millions of citizens, thousands of activists and hundreds of disarmament negotiators, every new dot during those years was just as much a threat to peace as those two over Hiroshima and Nagasaki.

Finally, in 1996 the Comprehensive Test Ban Treaty was wrapped up and quickly signed by a large set of countries. As of 2002, 165 countries had signed it and about half of those had formally ratified it. A crucial part of the treaty is watching everybody to ensure that there are no cheaters. The watchers are Earth scientists.

Seismic networks have always been a part of the Cold War—indeed, once it was learned exactly how deep explosions differ from ordinary quakes, the military was a constant presence in earthquake studies. Now the spies have come in from the cold, military and civilian programs have been consolidated, and a large international seismic network has been set up. This nuclear "neighborhood watch," part of the International Monitoring System (IMS), will be able to hear an explosion of one kiloton, and pinpoint it to within about 40 kilometers, anywhere on Earth.

The IMS will have some 170 seismic stations (50 primary and 120 auxiliary), and will coexist with three other networks: 80 air-sampling stations that will detect radioactive byproducts of any nuclear test, 11 sets of ocean-mounted hydrophones, and 60 atmospheric stations to pick up the infrasound made by explosions. All of the data—and this is where the envelope gets pushed—will be sent in real time to a central facility, open

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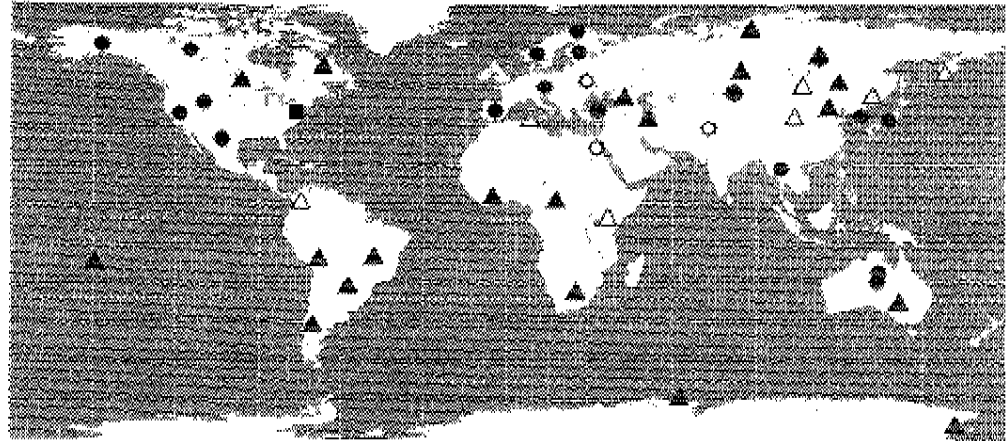

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Primary seismic stations of the CTBT monitoring network. Image courtesy CTBTO.

While the diplomats were dickering all these years, an international group of scientists has been testing the network that will be needed. [Switzerland's IMS Web site](#) exhibits seismograph tracings from the most recent nuclear explosions in India and Pakistan in 1998, and earlier tests in China (1996) and French Polynesia (1995).

American President Clinton, representing the first nuclear nation, was the first to sign the Treaty, and accordingly the U.S. has the largest web sites related to its role in the IMS. The seismic data from many stations flow through a national data center at the Air Force Technical Applications Center ([AFTAC](#)) in Florida, where they can be shared with scientists and institutions worldwide. These seismic measurements, as well as more data from the air-sampling, hydroacoustic, and infrasound networks, will flow to the central repository or International Data Center (IDC).

The majority of the seismic network has already been emplaced by the international earthquake consortium IRIS (Incorporated Research Institutions for Seismology), the U.S. Geological Survey, and the National Science Foundation. We are building a global set of ears-to-the-ground that will collect high-quality earthquake data while ensuring nuclear verification for the future. The cause of peace will pay huge dividends for science.

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Jan. 6, 2005 19:25 | Updated Jan. 6, 2005 20:01

## Egyptian paper: Israel-India nuke test caused tsunami

By JOSEPH NASR



The earthquake that struck the Indian Ocean on December 26, triggering a series of huge waves called tsunami, "was possibly" caused by an Indian nuclear experiment in which "Israeli and American nuclear experts participated," an Egyptian weekly magazine reported Thursday.

According to Al-Osboa', India, in its heated nuclear race with Pakistan, has lately received sophisticated nuclear know-how from the United States and Israel, both of which "showed readiness to cooperate with India in experiments to exterminate humankind."

Since 1992, the magazine argued, leading geological centers in Britain, Turkey and other countries, warned of the need "not to hold nuclear experiments in the region of the Indian Ocean known as 'the Fire Belt,' in which the epicenter of the earthquake lies.

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Geologists labeled that region 'The Fire Belt' for being "a dangerous terrain that can move at anytime, without human intervention," Al-Osboa' wrote.

Despite warnings not to carry out nuclear experiments in and around the 'Fire Belt', "Israel and India continue to conduct nuclear tests in the Indian Ocean, and the United States has recently decided to carry out similar tests in the Australian deserts, which is included in the 'Fire Belt', the Egyptian weekly magazine wrote.

"Last year only, Arab and Islamic states have asked the United States to stop its nuclear activities in that region, and to urge Israel and India to follow suite," Al-Osboa' reported.

Although Al-Osboa' does not rule out the possibility that the tsunami could have been caused by a natural earthquake it speculates however that, "while it has not been proved yet, there has been a joint Israeli-Indian secret nuclear experiment [conducted on December 26] that caused the earthquake."

The Egyptian weekly magazine concludes in its report that "the exchange of nuclear experts between Israel and India, and US pressure on Pakistan which is exerted by supplying India with state-of-the-art nuclear technology and preventing Islamabad from cooperating with Asian and Islamic states in the nuclear field, pose a big question mark on the causes behind the violent Asian earthquake."

Incitement against Israel and Jews in Egyptian media is usually limited to the context of the Israeli-Palestinian conflict yet exceptions are known to occur.

In August 2002, the Paris Supreme Court summoned Ibrahim Naafi', editor of the Egyptian daily Al-Ahram, for having authorized the publication of a controversial article entitled 'Jewish matza is made from Arab blood' in the October 28, 2000 edition of the paper.

Naafi' was charged with incitement to anti-Semitism and racist violence.



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## Experimental "Tsunami Bomb" Tests Conducted in the 40s; U.S. Was "Impressed"

by joejoehead at 11:29AM (CST) on January 2, 2005 | [Permanent Link](#) | [Cosmos](#)

SECRET WARTIME experiments were conducted off the New Zealand coast to perfect a bomb that could trigger devastating tidal waves, according to government files declassified in Auckland.

The New Zealand Herald, citing the files, said that senior United States defence officials believed the weapon had the potential to be as deadly as the atomic bomb. But the tsunami bomb, as it was known, was never fully tested and the war ended before the project was completed.

Its mastermind was Thomas Leech, an Australian professor who as the dean of engineering at Auckland University from 1940 to 1950. He was seconded to the New Zealand Army during the Second World War. He set off a series of underwater explosions that triggered mtnl tidal waves at Whangaparaoa, just north of Auckland, in 1944 and 1945.

Details of the research, known as Project Seal, are contained in 53-year-old documents released by the New Zealand Ministry of Foreign Affairs and Trade.

The papers, stamped "Top Secret", show that America and Britain were keen for Seal to be developed in the postwar years. They even considered sending Professor Leech to Bikini Atoll to watch the US nuclear tests and see if they had any application to his work.

In the end, he did not make the visit, although Dr Karl Compton, a member of the US board of assessors of nuclear tests, was sent to New Zealand to meet him.

In July 1946, a letter from Washington to Wellington Defence Headquarters stated: "Dr Compton is impressed with Professor Leech's deductions on the Seal Project and is prepared to recommend to the Joint Chiefs of Staff that all technical data from the test, relevant to the Seal Project, should be made available to the New Zealand government for further study."

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The announcement in 1947 that he had been awarded a CBE for weapons research led to speculation in some newspapers outside New Zealand about the nature of the work that he had been conducting. No details were released about it at the time because the project was still under way.

Neil Kirton, a former colleague of Professor Leech, told the New Zealand Herald that the experiments involved laying a pattern of explosives underwater to create a tidal wave.

Small-scale explosions were set off in the Pacific and off Whangaparaoa, which was controlled by the army at the time. Mr Kirton said he doubted whether people living in Auckland at the time would have noticed the trials.

What happened to Project Seal once the final report was forwarded to Wellington in the late 1940s is not clear.

Mr Kirton said: "If it could ever be resurrected, under some circumstances I think it could be devastating."

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Science

(A) Page 7

# Earthquakes From N-Tests

*Geographer's Contention Riles Geologists*

By Taro Iwata

Daily Yomiuri Staff Writer

—On Jan. 23 this year, more than 200 people in Tajikistan, Soviet Union, died in an earthquake that measured Richter magnitude 6.0. The day before, 1,600 kilometers to the northeast in Kazakhstan, the Soviets conducted an underground nuclear test of 20-150 kilotons.

—On Nov. 6, 1988, about 600 people were reportedly killed or injured in a strong earthquake, magnitude 7.6, in Yunnan Province, southern China. The day before, France tested a 50-kiloton nuclear device under Mururoa Atoll, some 12,000 kilometers away.

—On Nov. 25, 1988, a magnitude 6.0 earthquake shook eastern Canada and the northeastern United States. The following day, a similar earthquake shook a mountainous area in Qinghai Province, central China. On Nov. 24, France conducted a 50-kiloton nuclear test under Mururoa.

Three days after the North American earthquake, Gary Whiteford, a geography lecturer at University of New Brunswick in Fredericton, Canada, suggested a link between the earthquake and the French nuclear test.

Every nuclear test is followed two to three days later by an earthquake in another part of the world, Whiteford announced.

Whiteford, 47, acknowledged that geology was an interest, rather than a specialty. "Specialists more qualified than me do not speak out about the consequences of nuclear testing," he was quoted as saying.

Records show that many strong earthquakes follow

nuclear testing by one to four days, but there are also many instances where there were no earthquakes in this time frame.

Dr. Katsuyuki Abe, a seismologist at the Earthquake Research Institute of Tokyo University, said: "Suppose a heavy rain preceded some big earthquakes. Can you then automatically assume there will always be an earthquake after a heavy rain?"

The ground is constantly shaking with microseismic noises, caused by natural activities such as sea motions and winds, and by human activities such as subway operation and construction, he added.

The seismic waves from the French test site would be far weaker than natural local microseismic noise by the time they reached Yunnan Province, he said.

Dr. Robert Carmichael, an Iowa University geology professor currently attached to Meiji University, said Whiteford's theory is "scientific fraud . . . akin to witchcraft and astrology."

"It is not possible for a test to trigger an earthquake in a totally unrelated area," Carmichael said. "Stress isn't propagated that far in the crust.

"(These regions) have had earthquakes in the past and they will have them in the future. It is not related to nuclear testing," he added.

However, Abe and other Japanese seismologists said the triggering effect could not be completely ruled out.

Seismic waves made by distant nuclear tests "could cause an earthquake by releasing accumulated tension (in the ground)," said Dr. Tokihiko Matsuda, Abe's colleague at the institute.

Carmichael disagreed with

this, saying that nuclear tests are conducted at such a shallow level, they can have very little tension-reducing effect. This is particularly so where larger earthquakes are concerned, he said, as these tend to originate deep within the earth, far beyond any area where nuclear tests could penetrate.

"Some very small tremors may be set off in the local region associated with the testing," Carmichael said. "But, these are measurable only by sensitive earthquake equipment."

Whiteford, in a telephone interview, said he is not saying earthquakes are triggered by tests. "I'm just suggesting there is a highly dangerous coincidence."

For example, he said, only eight years between 1900 and 1949 saw more than 100 Richter 6.0 and larger earthquakes. Between 1950 and 1988, after nuclear testing began in earnest, only two years had less than 100 such earthquakes.

Whiteford admitted that he could not offer a seismological explanation. Carmichael, however, suggested that the statistics suffered from a sampling problem. "There wasn't a global network of observatories or people exchanging information on earthquakes until about 30 years ago," he said.

Carmichael also said the statistical analysis is meaningless. "There are enough large earthquakes happening every year for at least one to appear near the time of a nuclear test," he said.

Whiteford did not appear deterred by the criticism. "Time is running out," he insisted. If testing is not stopped, "millions of people" will die in earthquakes triggered by nuclear explosions, he said.

By GARY T. WHITEFORD

The science article that appeared recently in the *San Francisco Chronicle* and which is reprinted today in *The Daily Gleaner* deserves careful consideration. The nuclear powers have exploded over 2,100 nuclear bombs. But this latest information that the Russians have conducted further unannounced test from the Caucasus Mountains on the west to Siberia on the east, should make most observers very skeptical of the monitoring of the entire nuclear bomb testing program.

We are told the idea behind these tests was to create some form of a geology map for Russian scientists to better understand what lies below the Earth's surface. But with the detonation of nuclear bombs? And the U.S. monitoring stations were unaware of such tests? This is not the only time that unannounced nuclear bomb tests have been conducted. Several years ago, the Clinton administration issued a statement that indicated the U.S. had conducted over 200 previously unannounced tests.

Scientists have been at work since Soviet nuclear physicist and father of the Russian hydrogen bomb, Dr. Andrei Sakharov, suggested a casual link that a nuclear bomb explosion could trigger an earthquake. Have recent devastating earthquakes been the result of scientists working to perfect Dr. Sakharov's idea?

#### Sinister Purpose?

Perhaps the purpose is to build an underground seismic wave propagation map to determine how nuclear energy can be created at one Earth location and be seismically transferred to another faraway Earth location to create seismic consequences, or nuclear earthquakes. In effect, is the hidden agenda of the nuclear bomb tests a testing ground for underground nuclear war?

The ultimate objective of this would be to perfect the testing, so a precise understanding is gained on how this nuclear testing energy is directed. Is that why the American geologists were so interested in the Russian map produced by seismic blasts? Most observers would blame the devastation on a natural occurring earthquake. But what is at work is the nuclear earthquake.

Such nuclear bombs exploded underground are ultimately designed to create chaos in an unfriendly country and to destabilize economies by unleashing nuclear earthquakes. Tragically, this nuclear bomb energy is unpredictable. It can be misdirected, causing non-target locations and people to be impacted.

Is all this nuclear bomb testing simply an experiment to better understand the underground seismic wave map? Why else would the nuclear bomb testing nations persist with all these bomb tests over a 50-year period? For what purpose?

The major nuclear bomb testing nations met last week at the UN to renew the nuclear non-proliferation treaty. Is this just a public relations show? Discussions deferred and more study needed. Why? Very simple. More time is needed to try and put all the seismic map pieces together. Then the nuclear bomb testing countries will be in a position to unleash unprecedented nuclear earthquake damage, whenever and wherever they deem necessary. Those observers above ground will casually put the blame on another devastating earthquake.

Presently, it has been suggested that seismometers are in place to distinguish between man-made explosions and earthquakes. Like earthquakes, chemical and nuclear explosions release seismic waves of various types. For example, it has been determined that seismic waves from nuclear explosions travel significantly farther than those from chemical blasts. But where were the observers when all those unannounced American and Russian tests occurred? And how many more tests occurred that are still unannounced?

#### Hard To Distinguish

Perhaps it is impossible to distinguish between a one kiloton nuclear bomb blast and a small earthquake. The Hiroshima bomb dropped on Japan was 20 kilotons. It is very easy to transport a mini-nuclear bomb to a distant location and place it in a drilled hole some 1,500 feet below the ground. Then the bomb can be detonated remotely. Everyone thinks it is simply a small earthquake. Nothing to worry about. But then, some two weeks later, an unprecedented earthquake occurs in faraway China. Or, Southern California is hit. If the latter occurs, the U.S. would go back to the drawing board to try and better fit the seismic map pieces in their proper places.

Truths about nuclear testing will never be revealed. The only hope is to have a monitoring system in place that can detect who is cheating. But given the suspicious nature of unannounced nuclear bomb tests over the years, who is one able to trust?

Recently, Russia agreed to sell nuclear technology to Iran for \$1 billion. China is also following suit. Are the major nuclear bomb testing powers preparing for all-out underground nuclear war? Earthquakes in places not known for earthquakes should be cause for questions. Because who can now tell the difference between the detonation of a one kiloton nuclear bomb and the occurrence of a small earthquake? Iran, Pakistan, India, North Korea, Israel, Japan, South Africa. These nations are joining with the U.S., Russia, France, China, and Britain to ready themselves. Not for nuclear winter but for a nuclear showdown under the ground. The fingers will be pointed at that innocent player in all of this - the naturally occurring earthquake.

(Dr. Whiteford teaches geography at UNB)

# Deadly combination: H-bombs and earthquakes

BY GARY T. WHITEFORD

Prof. Whiteford teaches geography at the University of New Brunswick.

FREDERICTON

**S**INCE IT dropped "Little Boy" on Hiroshima and ushered in nuclear warfare 44 years ago this month, the United States has joined the Soviet Union and France in detonating more than 1,800 nuclear bombs. In the past 25 years, bombs have gone off on average every 7.3 days — the vast majority of them underground. What has all this cost?

Much of the environmental damage has been obvious. In the South Pacific's Mururoa atoll, the French have blown away an entire lagoon, causing so much damage that they are expected to move to a new site and start over again.

But something less apparent has also happened since nuclear testing began in earnest in 1951: the world is having more large earthquakes, and many of them are occurring within days of a nuclear blast.

The first half of this century witnessed 3,419 earthquakes — 68 a year — that reached a magnitude of six or higher on the Richter scale. Monitoring of disturbances this large has been fairly dependable since 1900. Since 1950, there have been 4,963 — 127 a year. The annual average has almost doubled since nuclear testing began.

But there is a wrinkle to this trend. The number of earthquakes of magnitude eight or higher has actually gone down. From 1900 to 1949, there were 101 of them (seven in 1906 alone, including the famous San Francisco quake of April 18 at magnitude 8.3). Since 1950, however, there have been only 30 and only three in the past 10 years.

This may be because the planet is now like an addict hooked on its

nuclear-bomb fix, releasing earthquake energy prematurely because of the explosions. But what happens if we stop testing? Will the old pattern of higher-magnitude quakes return?

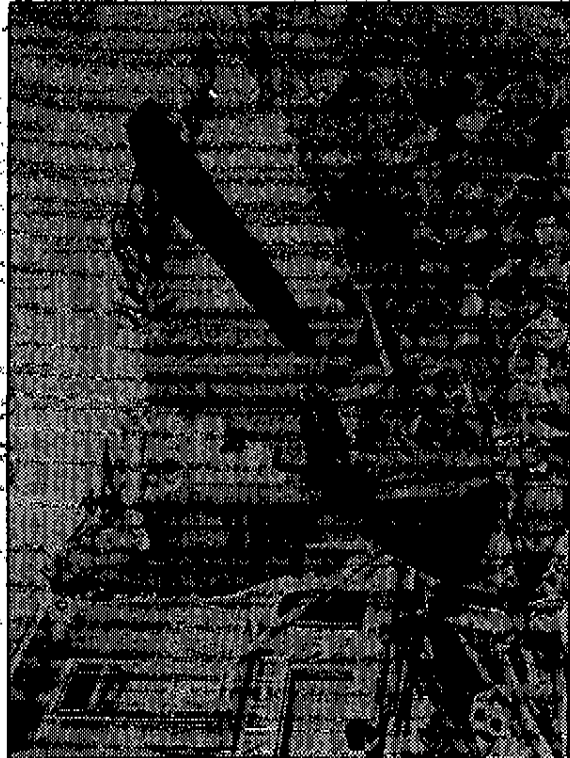
Some areas of the world may be willing to take that risk. For example, the South Pacific island nation of Vanuatu is used to earthquakes — between 1900 and 1950 it ranked second in the world in those of magnitude 5.8 and better.

But since nuclear testing began, the situation has grown even worse. Within five days of every U.S. underground test in Nevada, there has been almost a one-in-three chance that a magnitude-six quake would hit Vanuatu or the Solomon Islands, Nevada itself or parts of the Aleutian Islands off Alaska. And since 1963 the United States has tested underground 639 times.

Equally telling is the experience of the High Arctic island of Novaya Zemlya, where the Soviets have conducted 35 tests since 1963. The test site itself has received 18 per cent of the 5.8 earthquakes registered within five days of a test. Before 1950 it had recorded none.

**O**ther areas should also take note of when the Soviets test at Novaya Zemlya. Western Samoa, Mindanao, Vanuatu and the Japanese island of Hokkaido all have at least a 6 per cent chance of being hit within five days.

The busiest Soviet site is Semipalatinsk in Kazakhstan, where more than 400 tests have been conducted since 1963. Whenever there is a detonation at Semipalatinsk, the following areas have a good chance of having a 5.8 quake within five days: Fiji, the Kermadec Islands, Western Samoa, Solomon Islands, Vanuatu



Aftermath in Italy: quakes have doubled since nuclear tests began.

and Semipalatinsk itself. As for the French, between 1975 and last year, they set off 111 bombs at or near Mururoa, causing serious fractures to the coral atoll and constant contamination of it and the surrounding waters. Mapping out all magnitude 5.8 earthquakes to occur within five days of a French test shows that the Solomons and Vanuatu both have a one-in-10 chance of being hit.

There have been fewer big — or "killer" — quakes of late but they still happen and they, too, may be linked to nuclear explosions. Since 1953, a total of 32 earthquakes have taken human lives, and 20 of them have come within days of a nuclear detonation. The French tested last Nov. 5; a day later, more than 1,000 Burmese and Chinese died in a 7.3 quake. On Dec. 4, the Soviet Union detonated at Novaya Zemlya and three days later 60,000 Soviet Armenians died in a 6.8 quake.

The largest death toll in this cen-

tury came on July 28, 1976, when 800,000 people died following an 8.2 quake in Tangshan, China. The day before, the Americans exploded a bomb in Nevada.

Professor Yuri Seliverstov of Leningrad University has suggested that the environment and man's activities have a real effect on the planet's geologic evolution. He feels that, contrary to popular belief, the Earth's crust is not all that hard. Rather, rock that is dozens of kilometres thick is extremely sensitive and reacts keenly to external factors — in effect, it "breathes" in response to small shifts in atmospheric pressure.

If this is true, some areas of the world had better start paying very close attention to who tests nuclear bombs, where and when. Chances are they're going to be hit, as long as nuclear explosions go on. And if the Earth's fabric isn't as tough as we think it is, they're going to be hit hard.



LA TIMES

7-9-92

# Tests and Quakes

## Nuclear Tests Are Blameless—for Quakes

■ **Seismic shocks: Suspect what you will, the data just don't correlate.**

By RILEY R. GEARY

In the wake of the most powerful quake to strike the state in 40 years, people are wondering if it really was mere coincidence that the seismic spasms of June 28 were preceded just five days earlier by an underground nuclear blast in southern Nevada. Or was there perhaps a more sinister connection, as suggested by Paul Conrad's "Chain Reaction?" cartoon of July 1?

I am an ardent environmental activist who has attended more than a dozen demonstrations at the Nevada Test Site in the last six years, and have been arrested several times. So one might think that I would be more than willing to join with those seeking to blame our tectonic tremors on the tests, particularly given my perspective as a senior seismic analyst at Caltech.

While unease about earthquakes is certainly understandable, my own research leads me to conclude that the relationship between California quakes and nukes in Nevada is essentially nonexistent. Furthermore, those in the anti-nuclear movement who take advantage of the situation by pandering to public fears and misper-

ceptions risk compromising their own credibility, and they may end up diverting attention away from far more compelling and legitimate reasons to oppose continued testing—of which I would cite the threat of further proliferation first and foremost.

The problem is that few people have any real understanding of what constitutes a significant correlation between two sets of events that may be linked through cause and effect, let alone any insight into statistics or probability theory. Just because a quake happens to follow close after a nuclear test does not necessarily a correlation make.

Quakes have been with us since the dawn of time and will no doubt continue to inconvenience us after the last nuke is ancient history. To establish a correlation between the two, one would have to demonstrate that the incidence of quakes following nuclear tests has been substantially higher than what the long-term average seismicity would indicate. Other plausible explanations would also have to be ruled out, including random chance, given enough combinations to examine.

The fact is that the seismic record, when studied objectively and with the proper statistical methodology, simply does not support a contention that nuclear testing in Nevada, or anywhere else, has any effect of triggering earthquakes beyond the immediate area of the tests themselves—out to distances of at most 20 to 30 miles for the

larger blasts. This is true even for tests at or above the 150-kiloton limit we have observed since 1976 (equivalent to a seismic magnitude of 5.8 to 5.9), which presumably would have the most pronounced effect—if there actually were any effect.

The rather modest 3.9 magnitude of the June 23 test (suggesting a yield of perhaps less than a half-kiloton) and the even smaller 3.0 test June 9 make it doubly dubious that either could have played any part in helping to initiate our current seismic sequence, which in hindsight almost certainly began with the 6.1 Joshua Tree quake April 22.

The lack of any demonstrated statistical correlation between nukes and quakes could allow one to maintain with equally vacuous validity that earthquakes "cause" nuclear tests, rather than the other way round. Indeed, a rather tenuous case could be made that the time of most intense testing in Nevada, from the mid-1960s to 1976 (when weapons up to the megaton range were routinely detonated), actually corresponded with one of the quieter periods of Southern California seismicity— notwithstanding the 1971 Sylmar quake. I trust that even the most vociferous advocate of continued nuclear testing would hesitate to suggest that we set off even more nukes in an ultimately futile effort to try to keep the Big One at bay.

Riley R. Geary is a senior seismic analyst at Caltech. The views expressed are his own.

■ I read with great interest Riley Geary's article "Nuclear Tests Are Blameless—for Quakes" (Commentary, July 9). Unfortunately, he does not indicate which seismic records he has subjected to statistical analysis or exactly which statistical techniques he has followed.

His conclusions differ significantly from mine. I have conducted a long-term study of earthquakes, their location, size and frequency throughout the world using seismic data from the last 90 years. My study indicates that a significant disruption in the pattern of large magnitude quakes (6.0 and above) coincides with the advent of nuclear bomb testing. This disruptive pattern continues.

One can say that nuclear bomb testing has no effect on the triggering of earthquakes without having to demonstrate any connection. Regrettably, my statistical research leads to the opposite and more frightening conclusion: that nuclear bomb testing does have an influence on the occurrence of large earthquakes.

Both hypotheses cannot be correct. Either bomb tests have an effect or they do not. The pattern of large earthquakes has changed since the 1950s. Why? More research is necessary.

I support Riley Geary's desire to stop nuclear bomb testing, especially in view of the recent Chinese test of a one-megaton bomb in May.

At the very least, a halt to nuclear bomb testing will guarantee the arguments remain academic, saving the environment and possibly lives.

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# The Link between Earthquakes and Nuclear Testing

*Data suggests that many earthquakes occur as a result of nuclear testing, yet fewer 'killer quakes' have struck since testing began.*

*Is there a secret military agenda to control the number and strength of earthquakes?*

This paper is an attempt to understand distributions, patterns and directions of large earthquakes of Richter magnitude ( $M$ ) greater than or equal to 6 ( $M \geq 6$ ) since 1900. Secondly, attempts will be made to relate such large earthquakes to the patterns of nuclear testing. Such testing is conducted by the United States (USA), the [former] Soviet Union (USSR), France, the United Kingdom (UK) and China. Emphasis was placed on earthquakes of  $M \geq 6$  because these are the ones that cause considerable property damage and/or kill hundreds of people in short periods of time. Further, the data was more manageable when such magnitude earthquakes were considered. For example, there are between 5,000 to 7,000 earthquakes of  $M \geq 4.5$  each year around the world, whereas in any given year since 1900, the highest number of earthquakes  $M \geq 6$  was 214 (in 1957). As the magnitude threshold is lowered, many thousands more small events must be screened.

Earthquakes have always been part of the Earth's geologic history. On the other hand, nuclear testing only began in earnest in 1951. In 1963, such testing was moved underground. The greatest recorded earthquake death toll of 830,000 was in Shaanxi, China, in 1556. The worst in this century was on 28th July 1976 when the north-eastern Chinese city of Tangshan was levelled and about 800,000 people were killed. That quake measured  $M 7.8$ . Coincidentally, five days before the quake (23rd July), the French detonated a nuclear bomb in the South Pacific Mururoa Atoll, and, one day before (27th July), the USA detonated a nuclear bomb of 20-150 kilotons (KT) at the Nevada test site.

The nuclear era began on 16th July 1945 when "Trinity" was dropped 100 feet from a tower near Alamogordo, New Mexico. The yield was 19 KT of TNT equivalent. Soon after this test, on 5th and 9th August, the 15-KT nuclear device, "Little Boy", was dropped on Hiroshima, and the 21-KT "Fat Man" was dropped on Nagasaki, ending World War II.

Since 1945, the major powers have exploded a total of over 1,800 nuclear bombs (through March 1989). An average of close to 50 underground nuclear tests have taken place each year since 1980. There is little doubt that planet Earth is under severe environmental stress. It is not getting any better.

Recently the prestigious environmental research group, the Worldwatch Institute, issued their latest *State of the World* report which shows that the world is being pushed to the brink. "We are losing at this point, clearly losing the battle to save the planet," said the report's chief author, Lester Brown. The impending result, he warned, "will shake the world to its foundation". Ozone depletion, toxic wastes, acid rain, water scarcity and pollution, forest destruction and topsoil loss are all part of this impending environmental disaster. Perhaps it is high time to consider underground nuclear testing as a part of this infamous list.

## Patterns of Earthquakes, $M \geq 6$ , 1900 to 1988

For means of comparing patterns and trends of  $M \geq 6$  earthquakes with nuclear testing, 1950 will be used as the watershed year. There were no nuclear tests in that year, and only nine covering the years 1945 through 1949. The idea is to identify patterns in the first half of this century (1900 to 1949) and compare these to the second half of the century (1950 to 1988).

The most evident trend from Table 1 is the change in the comparative number of earthquakes of various magnitudes for the period before and after 1950. The first 50 years of this century recorded 3,419 such earthquakes of  $M \geq 6$ , an average of 68 per year. The last 39 years of this century recorded 4,963 earthquakes of  $M \geq 6$ , an average of 127 per year. In other words, the average per year for such earthquakes has about doubled in the second half of this century as compared to the first half of the century. Also, from 1900

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through 1949, there were only eight years in which there were over 100 earthquakes of  $M \geq 6$ . This entire cluster of eight was found between 1931 and 1941. The highest number was 182 in 1934, and this compared to a low of 17 in 1904.

Starting in 1950, the trend was completely reversed. In this 39-year period from 1950 to 1988, the overwhelming majority of years had a total of over 100 earthquakes of  $M \geq 6$ . Again, this compares to only eight years for the first 50 years of this century. The highest number was 214 in 1957, while the lowest was 78 in 1962. It is interesting to note that the years 1959 and 1960 were relatively free of nuclear tests. Coincidentally, two years later, the number of earthquakes  $M \geq 6$  dropped to only 78 in 1962 and 83 in 1963. These earthquake totals were the lowest for any given year covering the entire second half of this century.

When the  $M \geq 6$  earthquakes are divided into groups, another trend becomes evident. From 1900 through 1949, there was a total of 101 earthquakes of  $M \geq 8$ , with a yearly maximum of 7 in 1906. Those 1906 earthquakes included the famous San Francisco earthquake of 18th/19th April, at  $M 8.3$ , which killed over 400 people. But from 1950 through 1988, a total of only 30 earthquakes of  $M \geq 8$  were recorded. The most in any given year since 1949 were four, back in 1950. This included the great Indian earthquake of 15th August, at  $M 8.7$ , which killed over 1,500 people.

Thus, for the first half of this century, 101 earthquakes of  $M \geq 8$  were recorded, as compared to only 30 of such earthquakes for the second half of the century. And for the last 10 years there have been only three earthquakes  $M \geq 8$  recorded. The last was on 20th October 1986 when an  $M 8.3$  earthquake struck the Kermadec Islands of the South Pacific. This quake happened just four days after the USA exploded a 20-150-KT bomb in Nevada on 16th October.

It appears, therefore, that given such an increase in earthquakes of  $M \geq 6$  since 1950, and a decrease in earthquakes of  $M \geq 8$ , the observed increase must have occurred in between the two magnitude ranges. In fact, the increase has mostly occurred in the  $M 6.0$  to  $6.5$  range, as seen in Table 1. The average number in this range per year has tripled since 1950, from 24 to 72, as compared to earthquakes between  $M 6.5$  to  $< 7.0$ . The numbers for earthquakes  $M \geq 7$  have dropped since 1950 relative to the first half of the century. There were 1,145 (an average of 22 per year) from 1900 to 1949, and only 699 (average of 17 per year) from 1950 to 1988.

Magnitude	1900-1949	Average	1950-1988	Average
6.0 to <6.5	1164	24	2844	72
6.5 to <7.0	1110	22	1488	37
>7.0	1145	23	699	18
>8.0	101	2	30	<1

It should be noted that the ability to locate earthquakes in the world has increased dramatically since the turn of the century because of improved global communications and seismograph instrumentation. A dramatic increase in the number of recording stations has also occurred. For example, about 350 seismograph stations were operating in 1931, whereas today there are over 3,000 active stations around the world. It is generally conceded, however, that the largest earthquakes have been recorded relatively consistently since 1900, and these factors could have only a small effect on the number of events located per year for magnitudes above 6.0.

In conclusion, since 1950 the trend of the earthquakes  $M \geq 6$  is as follows. There have been 1,500 more in the last half of this century compared to the first half, and the average per year has doubled. Further, the increase has been most dramatic in the  $M 6.0$  to  $6.5$  range, while a dramatic drop is seen in earthquakes of  $M > 7.0$ . The question remains as to whether this trend will continue.

#### Patterns of Nuclear Testing, 1945 to 1989

The table below compiles the respective summary totals of nuclear explosions by country since 1945. The USA and USSR account for about 87% of the total.

Year	USA	USSR	Fr.	UK	Chin	India
1945 - 1962:	304	166	6	23	0	0
1963 - 1988:	629	451	165	18	32	1
Totals:	933	617	171	41	32	1
Grand Total: 1795						

Nuclear testing began in earnest in 1951 when the USA exploded 16 bombs. They later tested 77 times in 1958, half in the Pacific and about half at the Nevada test site. In 1962, a record of 98 USA bomb tests occurred, including a 600-KT bomb from a Polaris A2 rocket in the Pacific.

The largest nuclear test explosion conducted by the USA was a 15-megaton (MT) bomb detonated at Bikini Atoll, Marshall Islands, on 28th February 1954. The largest nuclear test by any country is believed to have been a 58-MT bomb detonated by the USSR on 30th October 1961 above the high Arctic island of Novaya

Zemlya. Since 9th November 1962, all USA nuclear tests have been conducted underground at the Nevada test site.

In 1962, a large number of nuclear tests were carried out (98 by the USA, 44 by the USSR) in anticipation of a halt to above-ground testing, which was a result of the Limited Test Ban Treaty signed in 1963. The French, however, continued to test above the water at Mururoa Atoll until 1975. And the Chinese did likewise, testing some 16 times above ground at the Lop Nor test site in Sinkiang Province until 1975. Tests are now limited to a maximum yield of 150 KT under terms of the Threshold Test Ban Treaty signed by President Richard M. Nixon and Soviet Premier Leonid Brezhnev in Moscow on 3rd July 1974. The ban did not take effect until 31st March 1976, and remains unratified by the US Senate. Testing was stopped completely in 1959 and 1960, and the USSR unilaterally stopped testing during a self-imposed moratorium for 19 months between July 1985 to February 1987. During that time, the USA conducted 26 nuclear tests. Since 1963, nuclear test sites by the five major powers have essentially been confined to the following locations:

Nation	Site Description	Latitude	Longitude
USA & UK:	Nevada Test Site (85 miles NW of Las Vegas)	37 N	118 W
France:	Mururoa, Fangataufa Atoll (720 miles SE of Tahiti, in Tuamotu archipelago)	22 S	139 W
China:	Lop Nor, Sinkiang Province	41 N	88 E
USSR:	1. Semipalatinsk, Kazakhstan	49 N	78 E
	2. Novaya Zemlya Island Arctic Ocean	73 N	55 E
	3. Ural Mountains, near Sarov	60 N	56 E
	4. Siberia, north Lake Baykal	61 N	112 E

The French testing site is very close to the Tropic of Capricorn (23.5°S Lat.) and is the only nuclear test site south of the equator. The Soviet Arctic site, the Novaya Zemlya Islands, is the only nuclear test site north of the Arctic Circle (66.5°N Lat.) and is presently used only once or twice per year. However, from 1958 through 1963 it was the main Soviet nuclear test site. The site was last used on 4th December 1988 when the USSR exploded a nuclear bomb between 20-150 KT. Three days later, on 7th December, the Soviet Armenian earthquake struck, registering  $M 6.9$  and killing upwards of 60,000 people, injuring 13,000 and leaving half a million people homeless. Another of these dangerous coincidences.

The total nuclear tests by all countries since 1945 is 1,795. The average for the 43.5-year period is one test every eight to nine days. If the period 1963 through 1988

is taken, the major powers are averaging a nuclear test every 7.3 days. The yearly average in the 1960s was 56; in the 1970s it was 47 tests; and in the 1980s, 47 tests. But the period of July 1985 to February 1987 was the self-imposed test ban by the USSR, so the 1990s should show the yearly level rise to above 50 again as they try to make up for lost ground.

Perhaps the only hope on this nuclear testing path is the attempt to limit nuclear tests to 1 KT with a view to total elimination. The Soviets emphasised a goal of immediate cessation of all nuclear tests, while the Americans stressed the need to improve verification capabilities and the need to continue testing in the absence of significant reductions in offensive nuclear weapons.

In 1988, each side visited the other side's nuclear test site to monitor an underground nuclear explosion. The idea was to make sure that both sides can verify whether a test yields more or less than 150 KT. The Soviets prove accuracy by their preferred monitoring method, which counts seismic units such as those used in monitoring earthquakes. In the American method, an electrical cable must be placed within 10 to 15 metres of the blast.

### Nuclear Testing and Earthquake Frequencies

The distribution of all earthquakes of  $M \geq 5.8$  between 1900 through 1949 clearly reflects the boundaries of the 11 major tectonic plate zones. All such earthquakes were located in zones or blocks of 10 degrees of latitude and 10 degrees of longitude, to give frequency and per-cent distributions on a global scale. The highest per cent is the Southern Philippines block at 3.95%, having recorded 135 earthquakes of  $M \geq 5.8$  during the period. Japan, in the Hokkaido area, is next at 3.07%, with 105 such earthquakes.

Table 4, below, identifies the major zones of high earthquake frequency, in some cases combining the values for adjacent blocks of latitude and longitude.

Table 4: Zones of High Earthquake Frequency ( $M \geq 5.8$ ), 1900 to 1949 (1 block =  $10^\circ$  of Lat.  $\times$   $10^\circ$  of Long.)

Location	Number of Earthquakes	Combined no. of Blocks of Lat and Long	% of All Earthquakes
Indonesia, New Guinea:	424	7	12.39%
Vanuatu, Fiji, Tonga:	377	5	11.03%
Japanese Islands:	310	4	9.07%
Cent. Amer., S. Mexico:	205	4	5.95%
Chile, Peru, N. Argent.:	204	5	5.95%
Philippines:	187	2	5.47%
Taiwan:	74	1	2.18%
N. India, Pakistan:	69	1	2.02%
New Zealand:	43	3	1.25%
S. Greece, W. Turkey:	42	1	1.23%

This convention for aggregating and presenting the data in percentage values within blocks of latitude and longitude, is used throughout this paper.

These area blocks or zones of latitude and longitude received nearly 56% of all the Earth's quakes of  $M \geq 5.8$  from 1900 to 1949, for a total of 1,935 earthquakes. By comparison, all other blocks of latitude and longitude each receive less than 1% of all earthquakes. This established pattern of earthquakes of  $M \geq 5.8$ , with highlighted zones of high frequency occurrence on a global scale between 1900 and 1949, will act as a control against which we can compare the patterns of earthquakes that follow nuclear testing. All such earthquakes were recorded either on the day of the test or within the four days afterward, for a five-day period.

### Atmospheric (Above-Ground) Nuclear Testing

The first area to consider is the Pacific Ocean. The US tests here totalled 106 and were conducted from 1946 through 1962. The principal sites are listed below:

Table 5:

Location	Number of Tests	Lat	Long
Eniwetok Atoll	43	11 N	182 E
Christmas Island	24	2 N	169 W
Bikini	23	11 N	165 E
Johnston Island	12	17 N	189 W
Pacific sites	4		

When we review the earthquake data, the following areas emerge as receiving more than their share of the  $M \geq 5.8$  earthquakes. Hardest hit following USA Pacific tests, relative to the pattern prior to 1950, were the blocks of latitude and longitude encompassing Sakhalin Island, the Aleutian Islands, Peru, Bolivia, Central America, Western Samoa, Vanuatu, Baja, California, Hawaii and Japan.

French testing in the South Pacific covered years 1966 through 1974 when they conducted 44 atmospheric tests, 39 over Mururoa Atoll and five over Fagataufa Atoll. The earthquake pattern after the French South Pacific testing is somewhat different, and the zones of high frequency earthquakes following these French tests were Western Samoa, Fiji, the Solomon Islands, the Alaska Panhandle, and the area between the Kamchatka Peninsula and Aleutian Islands. Interestingly, these regions of high earthquake activity following Pacific nuclear testing are all confined to the Pacific Ring of Fire, a zone of earthquakes and volcanoes that circles the entire Pacific Ocean. These data are summarised in Table 6.

British tests in the Pacific Ocean covered the period 1957 to 1958 and involved only

Table 6: Percentage of All Earthquakes ( $M \geq 5.8$ ) after US and French Above-Ground Nuclear Tests, Pacific Ocean, 1946 to 1975 (five-day period)

Location	Pre-Test Period 1900-1949	After USA Tests 1946-1962	After French Tests 1966-1975
W. Samoa:	2.78	4.91	12.50
Fiji:	2.31	2.46	4.17
Kermadec Is.:	0.50	1.84	0
Vanu-Coral Sea:	3.38	6.75	4.17
Solomon Is.:	2.98	1.84	16.67
Hawaii:	0.08	1.23	0
	0.09	1.84	0
N. Peru:	1.02	0.81	4.17
Lima, Peru:	1.28	3.07	0
Bolivia:	0.79	3.07	0
C. Rica, Panama:	1.05	4.91	0
South Mexico:	2.22	4.29	0
Baja, CA:	0.35	2.45	0
Alaska Panhan.:	0.50	0	6.33
W. Alaska:	0.41	1.23	4.17
Aleutian Is.:	0.88	7.38	0
	0.97	3.07	4.17
	0.88	2.45	4.17
	0.75	0.61	4.17
Sakhalin:	0.97	7.98	0
Hokkaido:	3.07	1.84	4.17
Tokyo:	2.46	3.68	0
S. Japan, Bonin:	0.53	2.45	0
Burma:	0.94	0	4.17
Tehran:	0.47	0	4.17

nine tests at Christmas Island ( $1.7^\circ$ N Lat,  $157^\circ$ W Long). Twelve British tests were conducted in Australia from 1952 to 1957. Since 1962, all British tests have been underground at the USA Nevada test site. Only the Christmas Island tests were examined here, but, once again, familiar terms emerge. See Table 7.

Table 7: Percentage of All Earthquakes ( $M \geq 5.8$ ) after British Above-Ground Nuclear Tests, Pacific Ocean, 1952 to 1957 (five-day period)

Location	1900-1949	After British Tests
Central America & S. Mexico:	4.64	20.00
Kermadec Is./Samoa:	7.13	15.00
Solomon Is./Vanuatu:	6.34	10.00

From 1951 until 1963, the USA tested 100 times above ground at the Nevada test site. When these test dates are matched with earthquakes of  $M \geq 5.8$  within a five-day period, the following areas show a higher-than-normal share of such earthquakes compared to the 1900-1950 period:

Table 8: Percentage of All Earthquakes ( $M \geq 5.8$ ) after USA Above-Ground Nuclear Tests in Nevada, 1951 to 1963 (five-day period)

Location	1900-1949	After USA Tests
Kermadec/W. Samoa & Vanuatu:	11.61	16.05
Kamchatka/Aleutian Is.:	4.48	10.82
Taiwan:	2.18	6.50
Solomon Is.:	2.98	5.22

The Soviet above-ground testing involved 166 tests from 1949 to 1962. About 70% of the known Soviet tests have occurred at their two main sites near Semipalatinsk in eastern Kazakhstan (50%), and on the island of Novaya

Zemlya, north of the Arctic Circle (20%). The above-ground testing was very active at Novaya Zemlya in the years 1958 to 1962. When the 79 tests at that site are matched to the  $M \geq 5.8$  earthquakes over the five-day period for those years, the following areas emerge as high-risk zones:

Table 9: Percentage of All Earthquakes ( $M \geq 5.8$ ) after USSR Above-Ground Nuclear Tests in Novaya Zemlya, 1958 to 1963 (five-day period)

Location	1900-1949	After USSR Tests
Costa Rica/Panama:	1.05	8.82
Mindanao, Philippines:	3.95	6.86
Vanuatu:	3.36	8.86
Kermadec Is.:	2.81	6.88
Kamchatka:	0.97	5.88
Java/Java Trench:	0.94	8.82
S. Aleutian Is.:	1.85	10.76

These seven areas were struck 55% of the time during a five-day period following an above-ground test at Novaya Zemlya, for the period 1958 through 1962.

The [former] USSR's main testing site today is Semipalatinsk. But from 1945 through 1962, only a total of 53 above-ground tests were recorded. This number also included tests conducted at their other mainland sites in Siberia and the Ural Mountains. Two regions are most noticeably tied to this particular Soviet nuclear test site: Taiwan at 9.48%, and the South Aleutian Islands at 23.28%. These two locations respectively received only 2.16% and 0.88% of all  $M \geq 5.8$  earthquakes during the pre-testing period of 1900 to 1949. Two other high-percent zones are the southern Mexico-Central America coastal region at 8.62%, and the western Samoa-Tonga region at 9.48%.

Another very interesting observation is that these mainland Soviet tests appeared to have little significant effect upon earthquake patterns in the Indonesia-Solomon Islands region, a zone that appears tied to other above-ground nuclear test sites.

### Underground Nuclear Testing

Underground or below-ground nuclear testing for the USA and USSR started in 1963. Through to 1988 the USA tested underground 629 times, almost exclusively at the Nevada test site. The Soviets tested underground 451 times, mainly at the Semipalatinsk location, but with 35 underground tests at Novaya Zemlya.

Table 10: Percentage of All Earthquakes ( $M \geq 5.8$ ) after USA Below-Ground Nuclear Tests in Nevada, 1963 to 1988 (five-day period)

Location	1900-1949	After USA Tests
Vanuatu:	3.36	6.81
Solomon Islands:	2.98	4.89
Nevada:	0.61	4.36
Aleutian Is. Block:	3.31	12.57
Santiago, Chile:	0.78	2.79

Observations from Table 10 show that around 30% of the time, during a given five-day period following an underground nuclear test in Nevada, an  $M \geq 5.8$  earthquake has hit the Vanuatu Islands, Solomon Islands, Nevada itself, parts of the Aleutians, or Santiago, Chile.

The 35 tests at Novaya Zemlya, 1963 through 1988, tie to familiar areas again, as given in Table 11 below:

Table 11: Percentage of All Earthquakes ( $M \geq 5.8$ ) after USSR Below-Ground Nuclear Tests in Novaya Zemlya, 1963 to 1988 (five-day period)

Location	1900-1949	After USSR Tests
S. Aleutians:	0.78	9.09
Mindanao:	3.95	9.09
Vanuatu:	3.36	5.08
Hokkaido:	3.07	8.06
Novaya Zemlya:	0	18.18
W. Samoa/Kermadec Is.:	5.59	15.15

The major [ex-]USSR nuclear test site in Semipalatinsk and associated mainland sites have received over 400 underground nuclear tests since 1963. Interesting patterns of earthquakes again follow nuclear tests at these sites. The South Pacific zone once again shows a relationship, but so too does the Nevada region, which previously only appeared with a high percentage following American nuclear tests in Nevada itself. The Aleutian Islands usually show an increase in earthquake frequency following nuclear tests, but this is not the case following a USSR underground test at Semipalatinsk, a marked contrast with the Novaya Zemlya test site. Further, the Semipalatinsk region itself received 3.15% of all  $M \geq 5.8$  earthquakes following nuclear tests at that site, as compared to a low 0.23% prior to 1950. See Table 12.

Table 12: Percentage of All Earthquakes ( $M \geq 5.8$ ) after USSR Below-Ground Nuclear Tests in Semipalatinsk and Other USSR Mainland Sites, 1963 to 1988 (five-day period)

Location	1900-1949	After USSR Tests
Solomon Is.:	2.98	8.92
Vanuatu:	3.36	6.49
Fiji, New Caledonia,		
Kermadec, W. Samoa block:	8.33	14.88
Honshu-Kyushu:	2.19	2.43
Nevada:	0.61	1.82
Aleutians:	2.55	3.24
Semipalatinsk:	0.23	3.51

The French conducted 1,112 underground nuclear tests at Mururoa Atoll in the South Pacific from 1975 through 1988. As pointed out by a recent National Resources Defence Council paper, the French have accounted for some 20% of all nuclear tests within the 10 years to 1988. Serious fractures of the coral atoll and constant nuclear contamination of the site and surrounding waters has occurred. Some

observers feel that the French will have to move these tests to the nearby Fagataufa Islands. When the earthquakes of  $M \geq 5.8$  are mapped within five days following all French underground testing, many Pacific regions again emerged as most affected and noticeable. See Table 13.

Interestingly, the French nuclear test site itself at Mururoa Atoll (22°S Lat., 139°W Long.) has a low 1.55% earthquakes observed in the five-day period following an underground test. This is quite different when compared to earthquake frequencies following underground tests at the three other test sites in Nevada (4.36%), Semipalatinsk (3.51%), and Novaya Zemlya (18.18%). This might be attributed to the fact that energy released from an underground nuclear test dissipates differently from a test site surrounded by an ocean.

Table 13: Percentage of All Earthquakes ( $M \geq 5.8$ ) after French Below-Ground Nuclear Tests at Mururoa Atoll, South Pacific, 1975 to 1988 (five-day period)

Location	1900-1949	After French Tests
W. Samoa, Kermadec Is.:	6.79	12.41
New Britain, Solomon Is.:	2.98	10.08
S. Aleutian zone:	2.61	7.76
Vanuatu:	3.36	8.30
Hokkaido:	3.07	5.43
Taiwan:	2.18	3.10
Mexico City, El Salvador:	2.22	3.10
Columbia:	0.85	2.33

### Atmospheric and Underground Nuclear Tests Combined

When all the above-ground (atmospheric) nuclear explosions are considered, certain areas of the world reveal high frequency patterns of the  $M \geq 5.8$  earthquakes following such tests. These areas, listed in Table 14, account for about 50% of all the  $M \geq 5.8$  earthquakes that followed an above-ground nuclear explosion within the five-day period.

Table 14: Percentage of All Earthquakes ( $M \geq 5.8$ ) after All Atmospheric Above-Ground Nuclear Tests Worldwide, 1950 to 1974 (five-day period)

Location	1900-1949	After Nuclear Tests
Kamchatka, Aleutians:	0.88	2.06
	0.97	2.06
	0.78	1.65
	0.88	7.27
	0.97	4.88
Vanuatu:	3.36	6.88
Solomon Is.:	2.98	4.39
Panama, Costa Rica:	1.05	4.12
S. Mexico, El Salvador:	2.22	3.87
Kermadec Is.:	0.50	3.43
	0.03	1.23
Taiwan:	2.18	3.29
S. Greece, Turkey:	1.23	2.06

The earthquake patterns following all underground nuclear tests are similar to those for the above-ground testing, and, when grouped together, account for about 50% of all the  $M \geq 5.8$  earthquakes that follow an underground nuclear explosion.

It is interesting to note that the Nevada area has a 2.65% chance of having such an earthquake. This compares to 0.61% for the pre-nuclear 1900 to 1949 period, and is slightly more than Taiwan's 2.47%. See Table 15 below.

Table 15: Percentage of All Earthquakes ( $M \geq 5.8$ ) after All Underground Nuclear Tests Worldwide, 1963 to 1988 (five-day period)

Location	1900-1949	After Nuclear Tests
Kamchatka, Aleutians:	0.88	1.06
	0.97	0.97
	0.76	3.35
	0.88	2.12
	0.97	1.85
Vanuatu:	0.70	1.76
	3.36	6.70
Solomon Is.:	2.98	6.70
Fiji, Tonga, Kermadec Is.:	2.05	1.59
	2.78	3.88
	2.31	3.88
Hokkaido:	0.50	1.68
	3.07	3.26
Papua, New Guinea:	2.22	3.09
Nevada:	0.61	2.65
Taiwan:	2.16	2.47

The continuation of underground nuclear bomb testing, mainly by the USA, [ex-]USSR and France, should alert certain areas of the world to note when and where the tests occur. Table 16 summarises the patterns of earthquakes of  $M \geq 5.8$  within a five-day period following nuclear tests at various test sites.

Table 16: Percentage of All Earthquakes ( $M \geq 5.8$ ) after Nuclear Tests at Various Test Sites (five-day period)

Area Affected	After USA /Nevada test	After USSR Semipalat. test	After USSR Zemya test	After French Munroa test
Aleutian Is.:	12.57	3.24	9.09	7.76
Samoa, Kermadec:	---	14.88	15.16	12.41
Vanuatu:	6.81	6.49	6.06	9.30
Solomons, N. Brit.:	4.89	8.92	---	10.08
Mindanao, Philip:	2.09	---	9.09	---
Taiwan:	2.09	---	---	3.10
Papua, New Guin:	2.79	---	---	---
Hokkaido:	3.88	---	6.06	5.43
Honshu-Kyushu:	---	2.43	---	---
Novaya Zemlya:	---	---	18.18	---
Semipalatinsk:	---	3.51	---	---
Nevada:	4.38	1.62	---	---
Mexico, El Salv.:	---	---	---	3.10
Santiago, Chile:	2.79	---	---	---
Totals:	42.05%	41.07%	83.63%	51.18%

Two areas show a significant tie to nuclear testing, regardless of who tests—notably, the Aleutian Islands chain and the South Pacific area inclusive of Vanuatu, the Solomon Islands, Western Samoa and the Kermadec Islands. Further, the Japanese islands of Hokkaido, Honshu and Kyushu should note who tests and when. The island of Mindanao should take some precautions when the [ex-]USSR test at Novaya Zemlya. For Nevada, it is necessary not only for them to monitor American tests, but also Soviet Semipalatinsk tests including the Urals and Siberia sites. The two most vulnerable areas in the South

Pacific, the Solomon Islands and Vanuatu, should monitor tests weekly. Each of these areas has up to a 10% chance per week of having an  $M \geq 5.8$  earthquake because of nuclear tests in the 1980s being conducted on an average of one per week.

### The "Killer Earthquake" and Nuclear Tests

Of all the earthquakes that do occur, the most frightening of them is the one identified as the "killer quake". It can be defined as an earthquake which kills at least 1,000 people. It is especially interesting to note a dangerous coincidence when all the killer earthquakes since 1951 are simply listed and matched to the dates of nuclear tests. Table 17 (see page 16), displays the 'match' between nuclear explosions and killer earthquakes.

Each of the 32 killer earthquakes which struck between 1951 and 1988 caused at least 1,000 deaths, with the worst being 800,000 killed in the 1976 M8.2 China earthquake. This China earthquake was the worst for deaths recorded in this century, and, coincidentally, the US tested a nuclear bomb one day before the earthquake hit. Over the 37 years of nuclear testing, 20 of the 32 killer earthquakes, or 62.5%, occurred on the same day or within four days of a nuclear test. The total death toll for these 20 killer earthquakes is over one million people. Table 18 shows the breakdown of these 20 killer earthquakes.

Table 18: Twenty "Killer Earthquakes" Matched with Nuclear Tests, 1951 to 1988

Number of Quakes	Days after Nuclear Test
12	Same day, or 1 day later
3	2 days later
2	3 days later
3	4 days later

(When two or more nuclear tests occur prior to a killer quake, only the test closest to the quake date is counted.)

Is this pure coincidence?

### Conclusions

Some people would question the idea of directly linking nuclear testing with the pattern of large, powerful earthquakes which follow within days of a test. Given the large number of such earthquakes per year, and the high number of nuclear tests per year, there might be a chance match between any given test and the occurrence of a large earthquake.

In the 1980s, there were an average of 47 tests and 120 earthquakes of  $M \geq 6$  per year. While a chance correlation might appear to be at work, the geographical patterns in the data, with a clustering of earthquakes in specific regions matched to specific test dates and sites, do not support the

easy and comforting explanation of "pure coincidence". The phenomenon clearly requires further study.

The primary purpose here was to identify frequency patterns of earthquakes following a given nuclear test. Obviously, more study and research of the question of a link between nuclear bomb tests and earthquakes is needed. This effort is simply a beginning.

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**Editor's Postscript:**

A couple of questions can be asked from a study of the data supplied in Gary Whiteford's article:

(1) Do the superpowers now have the capability of conducting a form of 'earthquake warfare' as a result of their nuclear bomb tests?

(2) Conversely, are the superpowers using nuclear bomb tests to prevent 'super earthquakes' of magnitude 8.0 or greater on the Richter scale? While it is true that the average number of medium-sized earthquakes (size 6.0 to 6.5 on the Richter scale) has tripled since nuclear testing began, the number of 'super quakes' has fallen.

Just before we go to print with this issue, France has detonated the first in its latest series of underground nuclear tests at Mururoa Atoll, on 6 September. So far, since then, four earthquakes of magnitude 5.5 or greater have struck, as follows:

\* 8 September, Southern East Pacific Rise: Lat. 56.2°S, Long. 122.0°W, magnitude 5.7 at 00:27:49.2 hours UTC.

\* 8 September, Southern East Pacific Rise: Lat. 56.1°S, Long. 122.0°W, magnitude 6.3 at 01:15:29.3 hours UTC (not considered an aftershock, as far as we can tell from the data).

\* 8 September, off the coast of Chiapas, Mexico: Lat. 14.9°N, Long. 94.2°W, magnitude 5.5 at 17:25:49.1 hours UTC.

\* 9 September, Northern Chile: Lat. 20.2°S, Long. 69.3°W, magnitude 5.6 at 20:58:40.2 hours UTC.

Although this article has dealt with the relationship between earthquakes and nuclear bomb tests, several more alarming effects are linked to nuclear tests:

\* In 1974, a scientist at the National Center of Atmospheric Research, Dr Matsushita, discovered that both the magnetic field of the Earth and the ionosphere were disturbed for 10 days to two weeks

after an underground nuclear test. In 1977 he was forbidden by the US Government from taking measurements for two weeks after a test. His work was classified shortly thereafter.

\* According to data from Tokyo University Aerospace Institute's satellite, *Tatyo*, nuclear testing has caused the temperature of the Earth's exosphere (outermost portion of the atmosphere, approx. 300 to 600 miles above the Earth) to rise abnormally by from 100 to 150°C.

\* The satellite also showed that nuclear testing is the cause of abnormal polar motion of the Earth. The normal polar movement, which makes a revolution every 430 days, is called the "Chandler Cycle". In other words, the position of the pole shifts radically at the time of nuclear explosions.

(Sources: *Wildfire Magazine*, vol. 3, no. 3, Winter 1988, vol. 4, no. 4, Spring 1989; *Pulse of the Planet*, Spring 1989)

Table 17: Killer Earthquakes, 1951 to 1988, Matched with Nuclear Tests (five-day period)

# Tests Per Year	Nuclear Test Date	Earthquake Date	Location	Magnitude	Deaths	Test/Quake Match?
17	1953: Mar. 17	Mar. 18	NW Anatolia	7.2	1,200	yes
33	1956: Jun. 6-16 (5 separate tests)	Jun. 10-17	Kabul, Afghanistan	7.7	2,000	yes
54	1957: —	Jul. 2	Iran	7.4	2,500	no
	1957: Dec. 9	Dec. 13	Iran	7.2	2,000	yes
3	1960: —	Feb. 29	Agadir, Morocco	5.8	12,000	no
	1960: —	May 22	Arauco, Chile	>8.3	5,000	no
145	1962: Sep. 1	Sep. 1	Buyin-Zara, Iran	7.1	13,000	yes
47	1963: —	Jul. 26	Skopje, Yugoslavia	6.0	1,100	no
67	1966: Aug. 19	Aug. 19	Varto, Turkey	6.9	2,600	yes
64	1968: Aug. 27, 29	Aug. 31	Dasht-e-Bayaz, Iran	7.4	12,000	yes
61	1970: Mar. 26, 27	Mar. 28	Gediz, Turkey	7.4	1,100	yes
	1970: May 28, 30	May 31	Chimbote, Peru	7.7	68,000	yes
46	1972: Apr. 11??	Apr. 10	Iran	6.9	5,100	??
	1972: Dec. 21	Dec. 23	Managua, Nicaragua	6.2	5,000	yes
46	1974: Dec. 27	Dec. 28	Pattan, Pakistan	6.3	5,200	yes
38	1975: Sep. 6	Sep. 6	Lice, Turkey	6.8	2,300	yes
45	1976: Feb. 4 (2)	Feb. 4	Guatemala City	7.5	23,000	yes
	1976: —	May 6	Italy	6.5	1,000	no
	1976: July 27	Jul. 28	Tangshan, China	8.2	800,000	yes
	1976: —	Aug. 17	Mindanao, Philippines	7.8	5,000	no
	1976: Nov. 23 (2)	Nov. 24	Eastern Turkey	7.9	5,000	yes
46	1977: —	Mar. 4	Bucharest, Romania	7.5	1,600	no
59	1978: Sep. 13, 15	Sep. 16	Tabas, Iran	7.7	25,000	yes
55	1979: —	Dec. 12	Colombia-Ecuador	7.9	800	no
55	1980: Oct 8	Oct. 10	Al Asnam, Algeria	7.3	4,500	yes
	1980: —	Nov. 23	Naples, Italy	7.2	4,800	no
57	1982: Dec. 10	Dec. 13	Dhamar, N. Yemen	6.0	2,800	yes
57	1983: Oct. 26	Oct. 30	Posinier, Turkey	7.1	1,300	yes
35	1985: —	Sep. 19	Mexico City	7.9	10,000	no
24	1986: —	Oct. 10	El Salvador	5.4	1,000	no
40	1988: Nov. 5	Nov. 6	Burma, China	7.3	1,000	yes
	1988: Dec. 4	Dec. 7	Armenia, USSR	6.8	60,000	yes