

Sizzle or Fizzle: The Indian Nuclear Test Soap Opera

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In May 1998 India conducted a series of tests of nuclear devices in the Pokhran range in the north-western Indian state of Rajasthan. Within days of the announcement of the tests doubts were raised about the yields of the tests by seismologists related to the CTBT (Comprehensive Test Ban Treaty) monitoring apparatus. The chorus that the tests had failed to yield expected results was joined by BK Subba Rao in 1998.

All the points that were raised by the doubters were rebutted by the test team over a period of weeks to months in a series of articles in scientific and lay media, while members of the test team including Dr. R.Chidambaram, Dr. A. Kakodkar and Dr. Sikka steadfastly maintained and upheld the statements that were made within days of the test. The controversy gradually died down until 2009.

In August 2009, Dr. K. Santhanam, who had been a member of the nuclear test team in 1998 as the DRDO person in charge of the field preparations of the test was reported as having brought up a series of allegations that the yield of the Thermonuclear test on May 11 1998 were less than announced. The detailed rebuttals and the counter arguments to the rebuttals to these allegations have been covered by the media comprehensively and will not be reproduced here, save for a list of sources at the end (20, 21, 22). The purpose of this article is to see if the *prima facie* case made about the failure of the thermonuclear test in 1998 can be supported or dismissed based on the statements made by the proponents of the "fizzle" (tests were a failure) side versus statements made by the "sizzle" (tests were a success) side.

Three preliminary requirements will have to be met before making the comparison of the statements made by the two sides.

- 1) A description of the terminology used in the debate
- 2) A list of statements put out by the test team with their identities
- 3) A list of statements put out by the doubters of the test results, and their identities.

TERMINOLOGY

India conducted a single nuclear test in 1974 and this test will be referred to as POK I. The tests conducted in 1998 have come to be called the "Shakti" series and 5 tests were conducted. These 5 tests can be conveniently referred to with the abbreviations S1 through S5. Three tests, which will henceforth be called S1, S2 and S3 were conducted on May 11 1998, and two more tests, called S4 and S5 were conducted on May 13 1998. Based on an article that appeared in the news magazine "Frontline" in 2009 (2) the details of S1 through S5 will be considered as follows:

S1: Thermonuclear device ("hydrogen bomb") whose yield is being doubted

S2: A fission device ("ordinary atom bomb").

S3, S4 and S5 were low yield devices (small test explosions) which can be ignored for the purpose of this article as they have not been questioned or discussed in the controversy over yields

S1, S2 and S3 were conducted simultaneously on May 11th 1998. S4 and S5 were conducted 2 days later on May 13th 1998

"Yield" refers to the explosive power of the bomb tested. In this article it is denoted to be in "kilotons" or kt for short. One kiloton is the equivalent of the explosive power of one thousand tonnes of TNT. One megaton would be the explosive power of one million tonnes of TNT. "Sub-kiloton" refers to "less than one kiloton". The "yield" of the tests has been disputed but exactly what is disputed is the cause of some confusion. Since three bombs (called "devices") were exploded simultaneously on May 11th 1998, the underground signals that were picked up from these explosions all over the world measured the total yield of all three devices S1, S2 and S3 taken together. But the dispute about low yield is not about all three devices, but about S1 alone. Nobody outside the test team was ever in a position to split up the total yield of 3 devices into 3 separate sub-yield figures. It is the sub-yield figure of S1 alone that is being disputed.

In this article the term "sizzle side" or "sizzle team" will refer to the scientists and others whose statements on the yield of the tested devices is being questioned. The main people in this group include Dr. R.Chidambaram, Dr. Raja Ramanna, Dr. Kakodkar, Dr. Sikka, Dr. APJ Abdul Kalam and some others. The name "fizzle side" or "fizzle team" will refer to the group of scientists and others who have disputed the yield of the S1 test. The main figures are Dr. K Santhanam, Dr. PK Iyengar, Dr. BK Subbarao and a few others.

A brief note on types of nuclear bombs. Nuclear bombs derive their explosive power from either "fission" when large atoms are split or from "fusion" when small atoms are forced together to fuse. The latter is what powers the sun. Getting fusion to occur is more difficult than getting fission to occur because the "fuel" for fusion must be compressed and heated by a fission bomb (called a "primary") sitting inches away from the fusion fuel (called the "secondary"). That means that the fusion has to occur in the split second before the fission bomb blows everything away. If the fusion occurs as planned the bang produced is vastly bigger, giving a larger yield.

It should be noted that "S2" was a straightforward fission bomb of the type that was used by the US over the Japanese city of Nagasaki on August 9th 1945, killing 75,000 people and injuring a similar number. The device called "S1" was the "thermonuclear bomb" (or hydrogen bomb), the one whose performance has been doubted.

STATEMENTS PUT OUT BY THE "SIZZLE" SIDE

- May 18th 1998: (3) *"Chidambaram also pointed out that the thermonuclear device or the hydrogen bomb used an advanced fission device to trigger the thermonuclear core. The fission trigger produced about 12 kilotonnes to activate the thermonuclear core to ultimately yield 45 kilotonnes. Maintaining that the yield of the hydrogen bomb could have been designed to be much higher, Chidambaram said it was deliberately kept low to avoid damages to the structures at the nearest village of Khetolai. The thermonuclear (45 kt), fission (15 kt) and low yield (0.2 kt) devices were detonated simultaneously.."*
- Frontline, June 1998: Dr. Anil Kakodkar: (4) *"So we designed the systems to suit that. Totally, we wanted to have a yield of around 60 kilotons. Of the three tests done together (on May 11), the yield of one (the standard fission device) was between 12 and 15 kilotons. The yield of the thermonuclear device was around 45 kilotons. The other was small, less than one kiloton."*
- The May 1998 Pokhran tests: *Scientific Aspects* by R. Chidambaram:(7) *"India conducted five nuclear tests on May 11 and 13, 1998 at the Pokhran range in Rajasthan Desert. The details are given in Table 1. The first three detonations took place simultaneously at 15:45 hrs IST on May 11. These included a 45 kt thermonuclear device, a 15 kt fission device and a 0.2 kt sub-kiloton (i.e. less than one kiloton) device."*

- The Hindu, July 21, 2001: (5) *"The objectives in Pokhran II were to test a 15 kiloton fission weapon, a 45 kiloton thermonuclear bomb, three subkiloton devices, and to validate the computer programmes for designing nuclear weapons, said Dr. Chidambaram. Unlike in India's first nuclear test in 1974 (Pokhran I), all the devices tested in Pokhran II were designed as weapons and hence their weight and size had to be kept to the minimum.....The thermonuclear bomb used a boosted fission device to start the fusion process. Dr. Chidambaram said the thermonuclear device had given the yield it was designed for. Steps had been taken in the design of the device to hold down its yield to just 45 kilo tons. This was done because two old tunnels dug in the 1980s had been used for Pokhran II. Given the depth of these tunnels, a more powerful explosion would have resulted in radioactivity being released into the atmosphere. It was also necessary to minimise seismic damage to a village five km. away."*
- Pokhran II: Five years later (6) *"The three simultaneous detonations on 11 May 1998 included a 15 kt fission device (atom bomb), a 45 kt thermonuclear device (hydrogen bomb) and a 0.2 kt (sub1kiloton) device."*
- Press statement by Dr. R. Chidambaram, Principal Scientific Advisor, Government of India and Dr. Anil Kakodkar, Chairman, Atomic Energy Commission, Mumbai, September 24, 2009 18:19 IST : (8) *"India conducted five nuclear tests of advanced weapon designs on 11 and 13 May 1998 at the Pokhran range in Rajasthan Desert . The first three detonations took place simultaneously at 15:45 h. IST on 11 May. These included a 45 kt thermonuclear device, a 15 kt fission device and a 0.2 kt sub1kiloton (i.e. less than 1 kiloton) device.*

....

The thermonuclear device tested on 11 May was a two-stage device of advanced design, which had a fusion boosted fission trigger as the first stage and a fusion secondary stage which was compressed by radiation implosion and ignited. For reasons of proliferation sensitivity, we have not given the details of the materials used in the device or their quantities. Also, our nuclear weapon designers, like nuclear weapon designers all over the world, have not given the fusion component of the total yield for our thermonuclear test.

Controlled thermonuclear yield: We tested our thermonuclear device at a controlled yield of 45 kt because of the proximity of the Khetolai village at about 5 km, to ensure that the houses in this village would suffer negligible damage. All the design specifications of this device were validated by the test. Thermonuclear weapons of various yields up to around 200 kt can be confidently designed on the basis of this test."

STATEMENTS PUT OUT BY THE "FIZZLE" SIDE

- Pokhran II not fully successful: Scientist (9): *"Based upon the seismic measurements and expert opinion from world over, it is clear that the yield in the thermonuclear device test was much lower than what was claimed. I think it is well documented and that is why I assert that India should not rush into signing the*

CTBT," Santhanam told TOI on Wednesday. He emphasised the need for India to conduct more tests to improve its nuclear weapon programme. The test was said to have yielded 45 kilotons (KT) but was challenged by western experts who said it was not more than 20 KT."

- Why K Santhanam said Pokharan II was not a success. Last updated on: August 28, 2009 13:31 IST: (10) *"I have maintained and will always maintain that the test was not more than 60 per cent successful in terms of the yield it generated. I have made this assessment based on the report of the instrumentation data that is available and also as the programme coordinator."*
- Scientists hurl mud bombs - Debate over Pokhran nuclear tests descends into slanging match: Tuesday , September 22 , 2009 : (11) *"K. Santhanam, who was involved in the nuclear weapons tests in Pokhran on May 11 and May 13, 1998, has said the thermonuclear device — a hydrogen bomb — tested on May 11 had failed to deliver its intended yield of 45 kilotons. Within weeks after the tests, a team of US researchers had expressed their doubts about the yield. But Indian nuclear scientists had argued in a research paper in a peer-reviewed journal that the tests had been successful and India did not have to conduct any more nuclear weapons test..."*

..An intact test shaft after the explosion, the absence of a crater, and instrument readings, he said, suggest that the main hydrogen bomb "failed to ignite at least anything like fully and even let alone explode with its designed power".."

..He has accused the nuclear establishment and the government of ignoring a 50-page document the Defence Research Development Organisation (DRDO) had submitted at the end of 1998 outlining its concerns about the hydrogen bomb test..."

- India lacks deterrence: Santhanam, 22 Sep 2009, ET Bureau: (12) *" former DRDO scientist K Santhanam on Monday said that he hoped for at least two more nuclear tests as the country was yet to acquire minimum deterrence..."*

... According to Mr Santhanam, the hydrogen bomb test, which was the second and most powerful of the three tests conducted on May 11, 1998, did not produce the desired yield. Saying that the H-bomb did not explode with its designed power equivalent of 25,000 tonnes of TNT, he claimed that the physical evidence at the site was also another proof of the failure of the thermo-nuclear device..."

- 'Two more tests to improve H-bomb', (13) *Reiterating his claims that the 1998 thermonuclear test was a 'fizzle', retired defence scientist K Santhanam on Monday said India would require at least two more tests with hydrogen bombs to collect information on parameters to simulate and improve their performance....*

... Santhanam said a 50 page DRDO report submitted to the government months after the May 1998 tests stated that the test yields were far lower than the claims made by the Department of Atomic Energy (DAE). But the DAE is believed to have given a point by point rebuttal to the DRDO report, which was authored originally by Santhanam. Both documents are classified..."

...Santhanam said he had based his views of the test on DRDO's instrumentation at ground zero, which, DAE officials have suggested, had malfunctioned on the day of the test. The former DRDO scientist—also a nuclear physicist trained at the Bhabha Atomic Research Centre argued that the H bomb test failed

since a 45 kt test at a depth of more than 100 mt could have created a huge crater on the ground, while none was found after the test.

- *The Myth Bomber: Outlook India Oct 5, 2009: (15) The instrumentation was done by the DRDO and the recording instruments were also part of the DRDO's responsibilities. The shaft in which the fission bomb was tested had a huge crater, even larger than the 1974 one. But the shaft where the thermonuclear device was tested did not cause the kind of damage that was expected. No crater was formed, the instruments also showed that the 45 KT yield had not been achieved...*

..we saw the crater was very large for the fission bomb, it was even larger than the one in 1974. But for the TN shaft, the damage was very little. No crater was formed.....Then they went to some rather ridiculous extreme by saying that the DRDO's instrumentation was faulty. This is amazing. With respect to the fission bomb, which gave more than 20 KT for sure, the DRDO's instruments worked perfectly. But when it came to the TN device, its instruments failed! This is talking with a forked tongue...If you look at the seismic data recorded by the DRDO instruments, which worked beautifully, you can tell that the 45 KT yield didn't happen..

Question: **In this case, you think only partial truth is being said?** Santhanam's response: *In this case, they are claiming we managed a yield of 45 KT. This is a blatant lie. It's a LIE—all capitals...*

Question: **So, what was the yield?** : *About 20 to 25 KT. ...India's minimum credible deterrent remains untouched because the fission bomb certainly worked like a song and, therefore, the minimum part of our deterrent is fully addressed. (But) certainly, we need a thermonuclear bomb,*

- *Blighted Strategic Future, Bharat Karnad (14), "The 'Shakti' series of tests in 1998 proved only that the miniaturized 20 kiloton (KT) fission bomb design, first tested in 1974, is militarily serviceable. All the other weapon designs - the boosted fission and, especially, the thermonuclear due to their 'simultaneous triggering' in Pokhran, produced confused multi-test explosion data sufficient to conclude that the fusion design, for instance, did not work because of partial thermonuclear burn authoritatively established by crater morphology and excessive traces of lithium in the rock and soil samples extracted from the L-shaped tunnel deep underneath the Thar desert where the devices exploded. Moreover, data from just one, and that too failed, test involving the decisive thermonuclear device is simply insufficient to write a software package simulating fusion reaction, leave alone help in developing new and more innovative designs for thermonuclear warheads/weapons of different power-to-yield ratios to fit varying missile nose-cone geometries."*
- *Pokharan II: The Incestuous Debate PR Chari R, #2976, 1 October 2009: (16) "Reverting to the scientific inquiry for estimating the yield of the TN device, the accepted methodologies used are seismic evaluations and radiochemical analysis. It is alleged that DRDO relied only on the seismic method (close-in acceleration), since radiochemical analysis was done by the DAE. In a PIB handout Chidambaram said, "the DRDO data had anomalies and had to be rejected." Santhanam argues that the DRDO estimated the yield of all the five nuclear devices tested during Pokharan II. The DAE accepted all these estimates, except for the TN device, suggesting selectivity in utilizing the DRDO data. Santhanam further argues that the crater formed by the TN device was 25 meters in diameter, consistent with a 25 KT nuclear explosion; in fact, he has also said that only a small depression was formed in the shaft mouth."*

- Pokhran II thermonuclear test, a failure (17/09/2009) :(17) *We have hard evidence on a purely factual basis, to inform the nation that not only was the yield of the second fusion (H bomb) stage of the thermonuclear (TN) device tested in May 1998 far below the design prediction made by the Bhabha Atomic Research Centre (BARC), but that it actually failed...*

First, after the TN test, its shaft remained totally undamaged: if the fusion stage had worked, the shaft would have been totally destroyed. Secondly, the A frame sitting astride the mouth of the shaft, with winches to lower and raise personnel, materials and so on, also remained completely intact. If the fusion stage had worked, the 'A' frame would also have been totally destroyed.

..The fission bomb yield from the DRDO's seismic instrumentation was 25 +2 kiloton and left a crater 25 metres in diameter. If the TN device had really worked with a yield of 50 +2 kt, it should have left a crater almost 70 metres in diameter. Instead, all that happened was that sand and mud from the shaft were thrown several metres into the air and then fell back, forming a small depression in the shaft mouth. There was no crater.

- Time to Test Again, P K Iyengar 02 Sep 2009: (18): *"..the fusion yield must have been 20 kt."*
- Non-Fissile doubts, P.K.Iyengar, Outlook Oct 26th 2009: (19) *"With this number for the thermonuclear burn—12 kt (the other 12 kt coming from the fission trigger)."*
- The Darkness Surrounding That Day In The Desert: BK Subbarao wrote: (24) *...Santhanam has now made some startling disclosures about the tests. The most startling of his revelations is that the shaft in which the H-bomb was placed "remained totally undamaged" after the test, and this constitutes clear and conclusive evidence that the device did not succeed—as was explained by this writer in several published articles in 1998, 1999 and 2000, based on seismic data from Indian and foreign seismic stations. Had the device worked, it would have damaged the shaft substantially. Besides, there are empirical formulae to calculate the yield of a nuclear explosion from the dimensions of the resulting crater. According to Santhanam, "there was no crater" over the shaft containing the H-bomb device, whereas there was a crater with a diameter of 25 m over the shaft containing the A-bomb or fission device, used to set off the H-bomb. This could be taken as conclusive evidence that the H-bomb did not succeed..*

COMMENTARY

The statements made by the test team – or the "sizzle side" listed above have been consistent and unchanging for over a decade to the point of being monotonous. This makes it easier to compare with the statements made by the different protagonists of the "fizzle side" who doubt the results of the 1998 tests.

The foremost spokesperson of the "fizzle" side is Dr. K.S.Santhanam who was part of the 1998 nuclear test team. His statements to the lay media have been listed above. The only consistent theme that Dr. Santhanam has followed in most of his statements is that the Thermonuclear test (S1) of 1998 was, in his view, a failure and that India must not sign the Comprehensive Test Ban Treaty (CTBT) until more tests are done. Apart from that Dr. Santhanam has consistently contradicted his own statements to the media in an act which can only be either deliberate obfuscation or puzzling lack of consistency. Here is a list of inconsistencies in his statements to the media:

- Dr. Santhanam has quoted Western seismological sources as having detected a low yield and said that *"British experts, however, later challenged the claims saying that the actual combined yield for the fission device and thermonuclear bomb was not more than 20 KT."* (9). However, in a later media interview (15) Dr. Santhanam clearly gives his estimates of the S1 (*"20-25 kt"*) and S2 (*"more than 20 kt for sure"*) devices of May 11th 1998 adding up to a maximum of over 45 kt – which is in line with the claim made by the "sizzle team" and contradicts the claim of the Western sources.
- Dr. Santhanam has stated that there was no crater formed by the S1 device in two separate reports. In two other reports he is said to have mentioned a 25 meter crater for the S1 Thermonuclear test. Either the test caused a crater or it did not. It cannot be both.
- Dr. Santhanam stated in one interview that the crater formed by the S2 (fission device) was larger than the crater formed by the 1974 POK I test. Dr. Subbarao quotes Dr. Santhanam as saying that the 1998 fission (S2) test created a crater of 25 meter diameter. However, reports of the crater radius of the 1974 POK I test (26) reveals that it was about 47 meters in radius (94 meters diameter) – that is more than 4 times larger, not smaller. Furthermore, Dr. Santhanam stated that a true 45 kiloton test should have created a 70 meter crater. That would still have been smaller than the crater of the 1974 POK I device which has been described as having yielded a mere 2 to 12 kt.
- Dr. Santhanam was quoted as saying that India *"lacks minimum deterrence"* (12) but later appeared to retract that and say that *"India's minimum credible deterrence remains untouched"*
- It was stated by Dr. Santhanam that the BARC (sizzle team) had rejected his (DRDO's) estimate of the yield of the S1 thermonuclear device, but had accepted the yield quoted by Dr. Santhanam's instrumentation for the S2 fission device. However this does not appear to be the case. Dr. Santhanam has quoted a yield of *"more than 20 kt"* for the S2 fission device, while the BARC announcement for that device is a yield of 15 kt.
- In one article (17) Dr. Santhanam hinted that fusion did not occur at all in the thermonuclear (S1) test (the device not only underperformed but it *"actually failed"*). This has been contradicted by the statements of Dr. PK Iyengar.

It is interesting to note that Dr. PK Iyengar, one of the foremost experts in fusion in India has made an estimate of the amount of fusion that might have occurred in the S1 thermonuclear device. The point here is that he has put a figure on it and does not say that fusion did not occur at all. This is contrary to the suggestions that have been made that fusion did not occur at all.

Bharat Karnad again uses the yield estimates from western sources but adds a new data point in speaking of *"excess Lithium"* found in the samples tested after the excess explosion. It is not clear if this is a typographical error in the report. The presence of Lithium *per se* has less meaning than the presence of excess Tritium. Dr. PK Iyengar has suggested that excess Tritium was present and has quoted that to support his view that fusion occurred but only partially. The fact that fusion occurred takes the bottom out of the claim that no fusion occurred at all.

Dr BK Subbarao was one of the first to claim that the 1998 thermonuclear test had failed (25). He based his statement on the same seismological information that Santhanam raised in 2009, in addition to the argument that a thermonuclear test must be measured in *"megatons"* and not in *"kilotons"*. The latter argument is untenable.

Dr. Chari, Dr. Subbarao and Dr. Santhanam have all used the “crater size” argument to question the yields of the 1998 tests. But their own statements in this regard are contradictory and self defeating. Dr. Chari argues that the 1974 POK I device yielded as little as 2 kilotons, while Dr Santhanam quotes a yield of 20 to 25 kt for the 1998 thermonuclear test (S1). But the crater of the “2 kiloton” device of 1974 has a bigger size than the “20 to 25 kt” thermonuclear device of 1998 as well as the “successful” S2 test that yielded “more than 20 kt”. Nobody has asked for an explanation as to how a test that is ten times as powerful can produce a crater that is much smaller. It appears that the rebuttal in this regard is consistent and accurate. The size of the crater depends on how deep the test device is buried. The biggest bomb in the world buried deep enough will produce no crater.

CONCLUSIONS

At the best of times nuclear physics is an arcane subject that is not understood by over 99 percent of the population of the world. Add to this the secrecy surrounding nuclear weapons and one has, in the scientific nuclear establishment of any country the makings of a secret society of people who can chant mysterious mantras to dazzle and befuddle onlookers. That is exactly what has been foisted upon an unsuspecting Indian public by scientists who sparked off an unseemly public debate.

In the end, judging purely from the statements made to the media by the “fizzle group” nothing is proven or certain regarding their claims. If the claim was that no fusion occurred – that does not appear to be the case. If the claim was that the total yield of the tests was too low – even that claim does not pass muster. The total yield figures quoted by the fizzle side in various statements are in fact closer to the announced yields by the sizzle team and are far higher than the yield figures claimed by the western sources cited.

The fact that the yields of the 1998 tests were deliberately kept low to avoid damage to nearby human habitations was announced right from the early days after the 1998 tests. This fact has been used by the doubters to claim that the low yields were because of failure and not by design. However the fact of damage to residences and water tanks in the village of Khetolai (27) – situated a scant 5 km away from the site of the 1998 tests is rarely mentioned when august members of the scientific community of India choose to make accusations against their colleagues about lies and fraud (1,15). If the tested devices had produced higher yields (such as the megatons as suggested by some doubters) the devastation in the nearby habitations can only be imagined.

The language that has been used in the widely publicized media “debate” about the alleged failure of the 1998 tests is more akin to what one would hear in a midnight argument between two drunken cycle rickshaw pullers on a Chennai street rather than from respected scientists who were heading departments tasked with helping to ensure national security. In this regard credit must go to those who avoided the use of such shameful language and character assassination in this widely reported media fracas.

If the intention was merely to cast doubt on the yield claims and express concern about national security it could have been done in a more dignified fashion via better channels, avoiding sensationalism and hyperbole. By firing media salvos it does not appear that the people who doubt the yields have done the nation or their own viewpoints any good. Since all the people involved in starting this unseemly debate were in high positions of responsibility and were all seen as respectable people, who should know better than to make a vulgar media spectacle out of a national security and national technical capability issue, one wonders if the real issue could possibly be entirely unrelated to national security. The possibility of personal grudges making irrational beings out of seemingly rational people cannot be dismissed by the general public who have been forced to willy nilly watch a mindless

and demeaning media boosted cock-fight amongst the nuclear moguls of our nation. One can only hope that such inane games are avoided by those who have easy access to the media by virtue of past positions held.

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"20 May 1998: Dr. B.K. Subba Rao, a former Indian Navy captain who worked on India's nuclear submarine program, challenges the Department of Atomic Energy's (DAE) claims that it successfully tested a thermonuclear device. According to Rao, only one explosion was registered by the seismic station within 437 kilometers from the blast area. Rao points out that seismic stations around the world recorded values between 15 and 25 kilotons. According to Rao, the positioning of the thermonuclear design within one kilometer of the two fission devices (both in one tube 300 meters apart) is "not sufficient to produce a phase difference and reduce the output of energy." Furthermore, the value of 45kt [DAE actually declared 43kt] is meaningless since the thermonuclear design must have a yield measured in megatons. Rao charges that the actual yield of the thermonuclear device tested on May

11 "was not even 30 kilotons." According to Rao, this result could mean the thermonuclear test either failed or that DAE probably tested a boosted fission device."

26) What Are the Real Yields of India's Test?

<http://nuclearweaponarchive.org/India/IndiaRealYields.html>

"The wide shallow crater produced (reportedly it had a 47 m radius and was 10 m deep; recent high resolution commercial satellite imagery indicates a crater radius of 60 m "

27) The Price of loyalty: <http://www.rediff.com/news/1998/nov/24pokh.htm>

"Loyalty, I learn, both from him and from people I talk to in Pokhran proper, has come at a price. Narsing Rao points to a corner of his hut, with an irregular crack running down the length of the granite wall. Later, as I walk around the village, I notice similar cracks on almost all the walls. Mementoes, I'm told, of the May blasts. Cracking granite takes some doing. But then, a series of nuclear blasts is some force, when you are just 4 km from the epicentre. And the real damage, I am told, is the cracks in their water tanks. In Khetolai, there are granite tanks in each home to hold precious drinking water, bought at Rs 300 per 3,000 litres, from tankers that come to the village thrice a week. That, by quick calculation, makes for less than a litre of potable water per head and now, even that is jeopardised. Didn't the government repair the damage, I wonder. That opens the floodgates. The locals all talk at once, till Narsing Rao looks angrily at them, the mien of village elder very much in evidence. He then tells the tale: May 11, the first blasts, the first cracks. May 13, more blasts, and a couple of homes collapse, though no one is hurt. Five days later, they were told of the impending visit of Prime Minister Atal Bihari Vajpayee to their village, on May 20. The village got ready 11 but Vajpayee did not come."

Shiv Sastry

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