

VOLCANIC HAZARDS AT THE KUDANKULAM

NUCLEAR POWER PLANT

R Ramesh and VT Padmanabhan

Source: <http://www.dianuke.org/volcanic-hazards-at-the-koodankulam-nuclear-power-plant/>

The Nuclear Power Corporation of India Ltd (NPCIL) is planning to commission two 1000 MW (e) VVER Reactors at Kudankulam Nuclear Power Plant (KKNPP) in a military style operation. This process was delayed for four months due to concerns of safety of the reactor. Volcanism is the major safety concern at Kudankulam. According to the newly released safety guidelines of the International Atomic Energy Agency (IAEA), the site must not have experienced any volcanic eruption during the past 10 million years.¹

The region around the KKNPP site had experienced small volume volcanic eruptions during 1998-2001 and the terrain has signatures of past volcanism. A summary of the findings published in 16 research papers on volcanism near KKNPP in land and in the Gulf of Mannar (GoM) was included in the Report by the Expert Committee of Peoples' Movement Against Nuclear Energy (PMANE) on 12 Dec 2011². The issue of volcanism which was conspicuously absent in the official narrative till recently was discussed for the first time in GOI EG Report dated 31 Dec 2012³. This paper is a summary of PMANE EC and GOI EG reports on volcanism.

ERUPTIONS DURING 20TH AND 21ST CENTURY

There were four volcanic eruptions within 32 to 75 km from the Kudankulam reactor campus between 1998 and 2001. All eruptions occurred near electric poles. The first one occurred on 5 August, 1998 at Abishekappatti, 60 km northwest of Kudankulam, 45 days after commissioning of the detailed project report (DPR) for KKNPP. The last eruption occurred four months before the pour of the first concrete on 31 March 2002. All sites of eruption are located on the northwest-southeast trending Thoranamalai shear passing within 5 km of the KKNPP.

The GOI Report says that they were electricity related

NPCIL sent a “team of officers of NIRM, AMD and NPCIL to RME sites” in December 2011, about a decade after the last event. Excerpts from their report state:

“There are reports of rock melting in Thirunelveli district during 1998 and 1999 and they are spatially associated with electric poles. The short circuited current (which was of high value) had passed through the pole for a long duration which generated heat and this has resulted in the melting of the reinforced concrete (RCC) material of the pole particularly at the bottom areas. The referred “rock melts” obtained are the melts of RCC material as well as soil materials in contact with the pole...Thus RME is related to electrical phenomenon which is clearly seen even today as visible burnt and melt marks on the two electrical poles in Pondicheri. Hence the reported “rock melts” are not the indicators of the underground volcanic activity and their relation with the existence of inferred volcanic vents is also not correct. It is related to electrical / lightning phenomenon.”

The Journal of Geological Society of India said they were volcanic eruptions

Three papers were published on these events in the Journal of Geological Society of India in 2000 and 2001^{4,5,6}. The first and the second papers were based on microscopic examination and chemical analysis of the samples respectively. The authors had presented evidences that the products of eruptions were volcanic in nature. The third paper noted that the “tripping of electricity from 11KVA power line was only of 3 to 9 minutes duration and this was insufficient to cause the scale of melting noticed at these sites”.

A reanalysis of the samples by Prof. Victor Rajamanickam confirmed that the eruptions were volcanic. Prof Rajamanckam wrote in 2002: “These materials are of glassy in nature containing sufficient gaseous cavities and vesicles. The material shows the presence of typical characters pertaining to volcanic rock. The specimen indicated the presence of volcanic beads of varying size including coalesced ones. It does not show any evidence of relation to host rocks. The chemical analysis of this glassy material is scanned with high rate of chromium and nickel. The silica in the glass also confirms its volcanic nature. The reconnaissance of geomorphological and geological studies has indicated the presence of lineaments in this region. Between Kanyakumari

and Mandapam, the entire region is controlled by the major east-west lineaments which divide the region into 5 different east-west blocks. These blocks behave independently and they tilt along the strike slip and develop the movement in these lineaments. When such is the tectonic structure of this area, the rock melt injections are confirming the activities of neo-tectonic movements.”⁷

The volcanic theory was proposed by geologists after analytical studies of erupted materials and they had also discounted the possibility of electric short-circuiting. NPCIL team’s conclusion based on visual verification of the sites and interviews with witnesses cannot be more authentic than the studies based on laboratory analysis, published in peer-reviewed journals.

RUSSIAN AMBASSADOR IN INDIA ON KUDAMKULAM GEOLOGY

The Russian Envoy to India, HE Alexander M. Kadakin held a press conference on 7th December 2011 in Delhi. Excerpts from the Ambassador’s press briefing published by Indo-Asian News Service: “On the talks of Haripur in West Bengal being another nuclear plant to use Russian reactors, Kadakin said it was not a concrete proposal and just a name that came up for discussion. Considering that Haripur was *geologically much worse than Koodankulam*,... India had agreed to suggest new site. We are ready to build. Where it will be convenient, it is India's choice not Russian choice." (<http://www.rusembassy.in/index.php?> Accessed on 25 Dec 11)

SIGNATURES OF PAST VOLCANISM

Carbonatite and basaltic dyke swarms, signatures of past volcanism have been reported from Kudankulam area since 1987. There are altogether 10 papers/ thesis on volcanism in land and 6 papers on volcanic vents in the Gulf of Mannar, 125 km southeast of Kudankulam. (List of scientific papers on geology and oceanography referred to in PMANE EC Report is given as annexure.)

According to the Government of India Expert Group, “the occurrence of Carbonatite dykes was reported about 2 km south of Kudankulam (8.11⁰N, 77.430E) by Ramasamy (1996). Except this report no such features are reported by any other authors in the region. (P-50) “From description of the features of dykes, volcanic plugs observed in the Kudankulam region (Ramasamy, 1996)⁸ shows these are very insignificant features in this region...The carbonatite dykes of number cannot be termed as swarm”. (P-51)

The following paragraph from a 2010 paper on Kudankulam deals with the features of the dykes, their significance and the citation history of Ramasamy’s 1996 paper:

“The area in and around Kudankulam, where India's largest nuclear power complex is being built, has a unique geology compared to the rest of the south-east coast of India. The terrain is transected by mafic bodies cutting into the granulite grade of metamorphic rocks. Despite the noted occurrence and structural characteristics, their importance in understanding the upper continental characteristics in and around Kudankulam and the Gulf of Mannar has not yet received detailed attention. *Ramaswamy (1987, 1991, 1995) and Ramaswamy (1993) have reported carbonatites and associated rocks with a few evidences of late Cenozoic volcano-tectonic deformation in Kudankulam...The configuration of sub volcanic intrusives in and around Kudankulam, deems a horst-graben structure criss-crossing the E-W trend of the coast. We suggest the presence of an anomalous body at a depth of 110-200m, whose surface expressions are marked by these sub-volcanic bodies. They have bisected the near surface crust in the form of plugs to the west and in the form of dyke swarms to the east, indicating severe crustal dilation to the east.*”⁹

AGE OF KUDAMKULAM VOLCANOES

GOI EG says: “As per IAEA code the location is to be devoid of volcanic activity for the last 10 Ma (IAEA, 2011). As per the present data from the Peninsula, no volcanic activity was reported in this part of land later than Deccan volcanism.” (P-53)

Deccan plateau experienced a series of volcanic eruptions, known as Deccan Volcanism some 65 million years ago. The southern part of the Indian Peninsula has long been regarded as a stable area free from any later eruption. This is an outdated notion as there have been a series of seismic activities in Kerala-Tamil Nadu. Ramaswamy and Balaji conducted a study to evaluate the signatures of recent tectonism in South India using data from the Indian Remote Sensing Satellite. The study revealed “characteristic signatures supporting Pleistocene tectonism in Tamil Nadu and Kerala.”¹⁰ (Pleistocene = 12,000 to 1,800,000 years before present)

In 2002, Prof Victor Rajamanickam had recommended to defer construction activities at KKNPP till detailed study of the tectonism of the region. “Over and above, the seismic tremors, tectonics in this region is also bringing a question of stability for the area. Large-scale studies have already brought forward Achankovil Shear Zone’s role in destabilizing this block. Under such circumstances, it is a must before going for any major structure in Kudankulam; one has to ensure the tectonics of this block. It is lying on a lineament plane. So it is a must to take up micro-level studies for confirming the tectonic stability of this landmass in the region before launching a major plant in Kudankulam. (Ref 5)

CONCLUSION

The Government of India Expert Group accepts that there are signatures of past volcanism in the area, but they reassure that these are insignificant features. The papers they refused to study show that these are more than significant. The other main contention is regarding the time of the last eruption. One study published in 2005 says that the region experienced volcanism during the Pleistocene Epoch – 12,000 to 1,800,000 years - much closer than the IAEA cut-off point of 10 million years. Detailed ageing studies can reveal the more precise age of past eruptions. Regarding the issue of recent eruptions, NPCIL methodology has not been scientific at all. In the absence of more scientific data, the conclusion in the papers published in the Journal of Geological Society of India stands uncontested. Considering these, it is imperative to undertake a volcanic hazard study as mandated by IAEA. Commissioning the reactor in a hurry, in spite of the Russian Ambassador’s remarks about the geology of Kudankulam, may have serious consequences for the entire peninsular India.

ANNEXURE

LIST OF GEOLOGICAL STUDIES IN KUDANKULAM REGION FOR VOLCANIC SIGNATURES AND GEOCHEMISTRY

LAND VOLCANISM

1. Ramaswamy R 1987. Reactivation of Eastern ghatpaleorift system during tertiary and other periods, Proc. In Nat. Sem. On Tertiary orogeny, Banaras Hindu University, Varanasi, 107-127
2. Ramaswamy R 1991. Occurrence of Soda-trachyte near Kudangulam village, Tamilnadu, Current Sci., 61, 401- 402
3. Ramaswamy, M. 1993. The evidence of late Cenozoic volcano tectonic deformations in Kudangulam, near Cape Comarin, Tamilnadu, Proc. Of IGCP Report on coastal evolution in Quaternary period, Madras 18-20
4. Ramaswamy, R 1995. Occurrence of olivine Tephroite and carbonate Tephrite in Kudangulam area, near Cape Comorin, Tamilnadu, India, Journ. Geol. Soc. India, 45, 331-333
5. Ramaswami, S.M. and Balaji, S. 1995. Remote sensing and Pleistocene tectonics of Southern Indian Peninsula, Int. J. Remote sensing, 16, 2375-2391
6. Ramasamy, R. 1995, Effects of metasomatism on the country rocks around the carbonatites of Kudankulam area. Tamilnadu. J. Geol. Soc. India Vol. 46, P. 117-123.
7. S.Ramasamy, J.Armstrong-Altrin San, 1998 “Inferences on Rhodoids from Neogene Carbonates of Kudankulam, Tamil Nadu”, Journal Geol.Soc.India, Vol 52, Sept 1998, p-344
8. Shahin, M.G. (2001) Coastal Ridge and Dyke Swarm in Radhapuram Taluk, Tirunelveli, Tamil Nadu- a geological appraisal. (M.Sc. dissertation)
9. Biju Longhinos and Rama Sarma, 2001 “ Seismo-Tectonic Signatures in and around Kudankulam, Tirunelveli District, Tamil Nadu”, (unpublished)

10. Biju Longhinos, Anand S P, and Mita Rajaram, "Physical Geology of Subvolcanic Systems : Laccolith, Sills and Dykes", LASI 4 Conference, Moab and Mount Hillers, Utah, USA, (22-26 September 2010)

VOLCANISM (and Tsunamigenic Sources) IN THE GULF OF MANNAR

1. Janaka Wijetunge, "Assessment of Potential tsunamigenic seismic hazard to Sri Lanka", International Journal of Disaster Resilience in the Built Environment, Vol 1, No.2, 2010, pp-207-220
2. Vestal W and Lowrie A, 1982, Large-scale Slumps off Southern India and Sri Lanka", Geo-Marine Letters, Vol.2, pp171-177
3. Sastri V V, Venkatachala, BS and Narayan, V; 1981, The evolution of East Coast India. Paleogeogr-Palaeoclim-Palaeoeco., pp.366 23-54
4. Murty GVK, Y Satyanarayana and T Pradeep Kumar; 1994, Magnetic Profile Across Gulf of Mannar, J Geol Soc India, Vol.44, pp.443-449
5. Das SK, N. Phanishekar and R. Mahadevan, "Understanding of Volcanic Intrusives and Hydrocarbon Habitat Through Integrated Study in Gulf of Mannar Offshore, Cauvery Basin", Seventh International Conference and Exposition in Petroleum Geophysics, Hyderabad, 2008
6. Hedervari P, 2010, Volcanism and seismicity in the Indo-Australian seismic belt: manifestations of intraplate tectonics, Ann Geophysics, Vol 31; Issue: 1; pp 111-14

STUDIES OF 20TH/21ST CENTURY VOLCANISM AT KUDANKULAM

1. G. Victor Rajamanickam, N. Chandrasekar, " Extrusion of Rockmelt in the vicinity of high tension electric line", in Journal of Geological Society of India., Vol.55, March 2000, p.109

2. G. Manimaran, P. Sivasubramaniyan, M. Senthiyappan, “Rock Melt Extrusion at Abishekapatti, Tirunelveli District, Tamil Nadu -A Report”, in Jour. Geol. Soc. India, Vol.57, 2001, pp.464-466
3. R. Ramasamy, “Molten Rock Extrusions”, in Journal of Geological Society of India., Vol.55, March 2000, pp.221-226
4. V Rajamanikkam, 2002, Study Report given to Dr. N. Markandan, Former Vice-Chancellor, Gandhigram Rural University, dated 05/03/2002

References

¹ IAEA Safety Standards DS405 Rev. 11, Date: 2011-05-27

² Report of the People’s Movement Against Nuclear Energy (PMANE) Expert Committee On Safety, Feasibility And Alternatives To Kudankulam Nuclear Power Plant (KKNPP) 12th December 2011 <http://www.firstpeoplesfirst.in/articles.php?page=2>

³ AE Muthunayagam et al, 2012, Supplementary Report On Safety of Kudankulam www.pibchennai.gov.in/karuvooram/.../KKNPP31.01.2012.pdf

⁴ G. Victor Rajamanickam, N. Chandrasekar, “ Extrusion of Rockmelt in the vicinity of high tension electric line”, in Journal of Geological Society of India., Vol.55, March 2000., p.109

⁵ G. Manimaran, P. Sivasubramaniyan, M. Senthiyappan, “Rock Melt Extrusion at Abishekapatti, Tirunelveli District, Tamil Nadu -A Report”, in Jour.eol.Soc.India, Vol.57, 2001. .

pp.464-466

⁶R.Ramasamy, “Molten Rock Extrusions”, in Journal of Geological Society of India., Vol.55, March

2000., pp.221-226

⁷ V Rajamanikkam, 2002, Study Report given to Dr. N. Markandan, Former Vice-Chancellor, Gandhigram Rural University, dated 05/03/2002

⁸Ramasamy (1996), “Carbonatite dykes from Kudangulam area, near Cape Comorin, Tamil Nadu”, J Geol. Soc. India, Vol.48, pp.221-226.

⁹Biju Longhinos, Anand S P and MitaRajaram, “Physical Geology of Subvolcanic Systems : Laccolith, Sills and Dykes”, LASI 4 Conference, Moab and Mount Hillers, Utah, USA, (22-26 September 2010)

¹⁰Ramaswami, S.M. and Balaji, S. 1995. Remote sensing and Pleistocene tectonics of Southern Ondian Peninsula, Int. J. Remote sensing, 16,2375-2391