

The agnostid fauna from the Middle Cambrian of Zanskar is closely comparable with that of the adjoining basins of Kashmir and Spiti. In Kashmir the agnostids consisting of different species have been described from *Solenopleura-Tonkinella* zone of Middle Cambrian<sup>8</sup>. Agnostids from Zanskar are also comparable with the assemblage recorded from *Prychognostus gibbus* zone of Middle Cambrian in Australia<sup>9</sup> and with the same zone in North America<sup>10</sup>. The Agnostid fauna presently described and other polymerid fauna indicate a shallow marine condition of deposition.

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## Gas emanations and subterranean sounds/microearthquakes in Marathwada, Maharashtra, India

After the great devastating earthquake of Killari on 30 September 1993, the Marathwada region is again experiencing microearthquake activity. This microearthquake activity is also accompanied by subterranean sounds and gas emanations. Earthquakes are many times accompanied by gas eruptions at high pressure. When this gas at high pressure comes out from small pores or fractures, it makes sharp sound which includes rushing sound<sup>1</sup>. The Killari region of Latur district has received two tremors on 29 August 1996, at 12.10 am and 12.30 am and two tremors on 2 September 1996, at 1.30 am and 1.52 am. These tremors were of magnitude 4 (*Lokmat* newspaper dated 29 September, 1996). These tremors were followed by gas emanations at Poharegaon 29 km NW of Latur and at Gunj 35 km NW of Nanded (Figure 1). Subterranean sounds were also heard in Poharegaon.

A week following the earthquake tremors received on 29 August 1996, there is report of gas emanations and it continued for a few days. At Poharegaon, gas emanations started on 6 September 1996 and continued till 12 September 1996 while at Gunj emanations started on 7 September 1996, and continued till 9 September 1996. The description of the sites is as follows:

Site 1 Poharegaon (Taluka Renapur, District Latur): The site of gas emana-

tion is about 2 km NW of Poharegaon. Gas emanations were first felt by animals and they turned their way because of the hissing sound. Then villagers reported an odourless emission coming out up to 1 ft height from small pores of

0.5 cm diameter in an area of about 0.5 m diameter. The pores were observed only on the upper 4 inches of soil cover (Figure 2a). The hissing sound could be heard up to the distance of 125 feet. After closing one hole, a

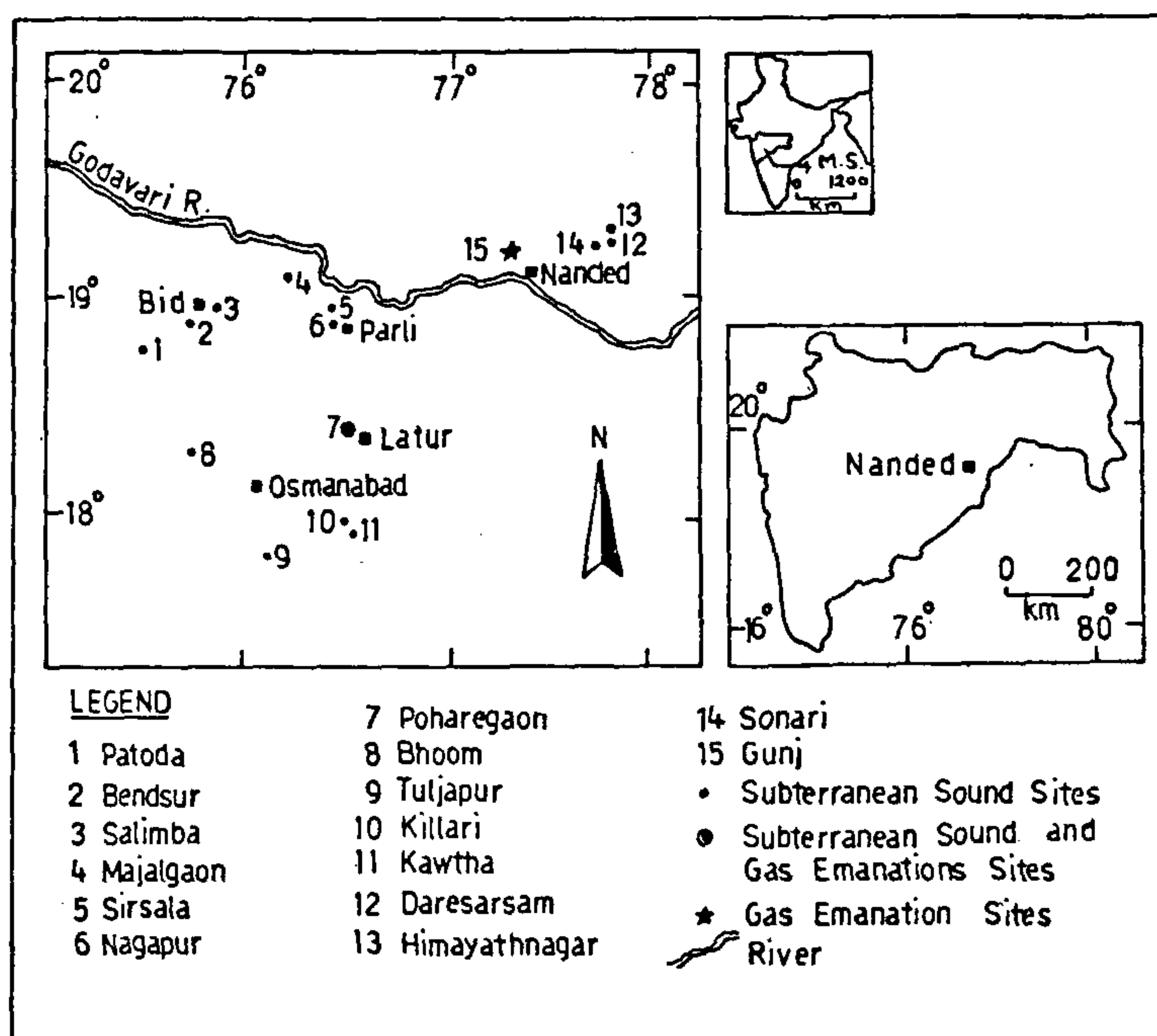
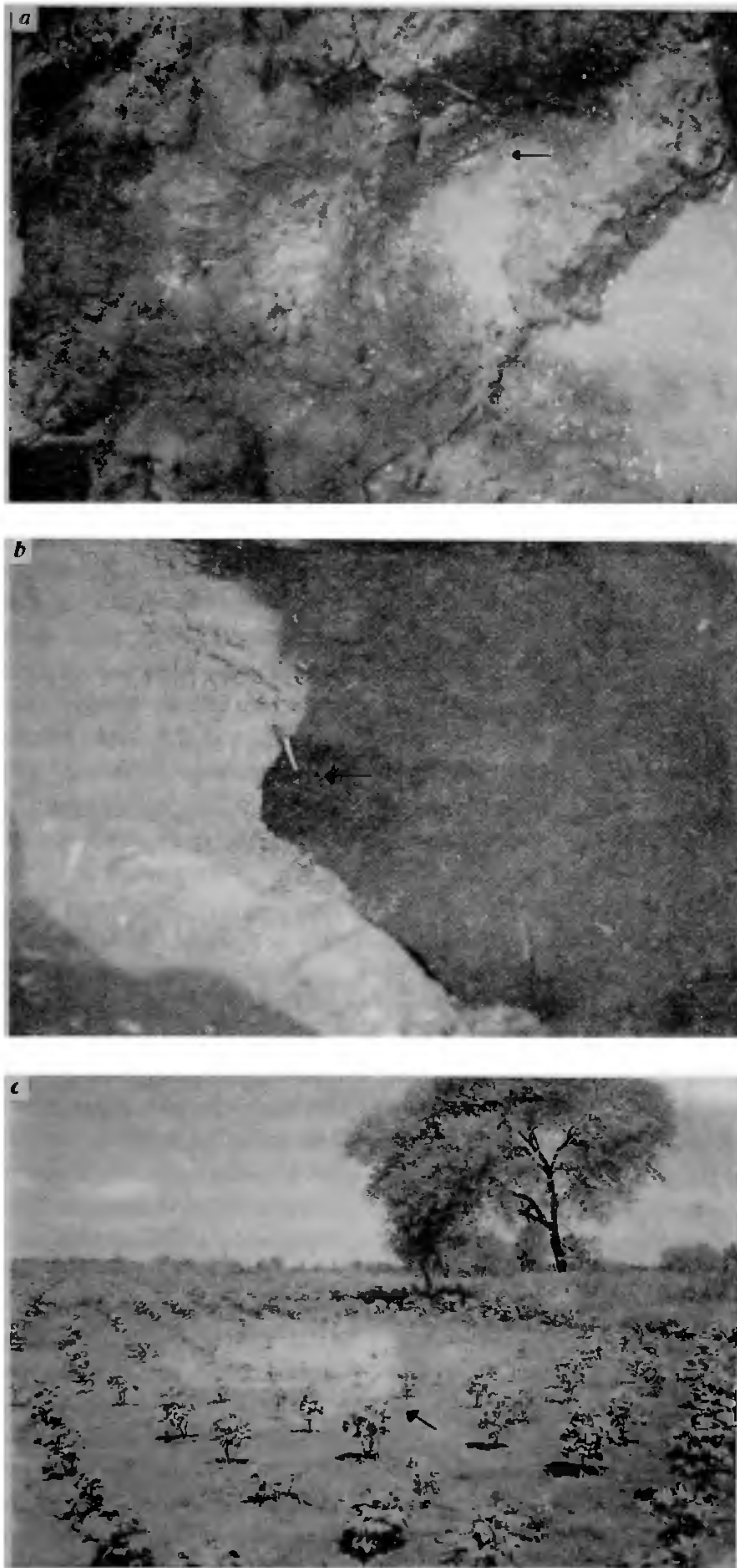


Figure 1. Location map of the sites.





**Figure 2.** *a*, Gas bubbling out (Poharegaon); *b*, Small hole through which gas blew out (Gunj). Note that villagers have excavated the soil up to 2 ft to find out the source of gas emanation; *c*, Water clogging near the site of gas emanation (Gunj).

new one used to open up and after pouring water on these holes, water showers were thrown into air up to the height of 1/2 ft. Subterranean sounds are also reported.

The gas emanations occurred after the region had received heavy rains. After the earthquake of 30 September 1993 also,

gas emanations had occurred just after the Latur region received heavy rains<sup>2</sup>.

When our team visited the site, water clogging was observed just by the side of the gas emanation site, and gas emanations had almost subsided. Gas was seen to bubble out only when water was poured on these holes. Termites were

reported to be coming out during emanation. The temperature recorded in the holes from which gas was coming out appeared to be normal. It was 27.5°C and there is no report of ground heating during gas emanations.

**Site 2 Gunj (Taluka Vasmat, District Parbhani):** The site of gas emanation is about 1 km south of Gunj. The river Ahana which follows the lineament trending N60W–S60E is on one side of the gas emanation site and a small stream which also follows a minor lineament trending E–W is on the other side of the gas emanation site. There is no effect of microearthquake in this village but gas emanations are reported. Subterranean sounds are not reported from this village. The gas is reported to be odourless and temperature was also normal. The area is not reported to have become hot. Gas emanation was only through one hole of diameter 1 cm (Figure 2*b*). Water clogging was observed just by the side of the gas emanation site (Figure 2*c*). Termites were reported to be coming out during emanation. Though the gas is reported to be odourless, it is reported that a person who came in contact with the gas had swelling on his hand and face and felt irritation and a burning sensation. The site could not be visited during gas emanation and hence no samples of gas were collected.

**Site 1: Poharegaon area** is covered by basaltic lava flows. A basaltic flow consist of two units – a lower massive and compact basalt and upper vesicular or amygdaloidal zeolitic basalt. The massive basalt is dense, dark grey to black, fine grained with only few large vesicles. Amygdaloidal basalt is brown to greenish with almost all vesicles filled with secondary mineral zeolites<sup>3</sup>.

Amygdaloidal basalt occurs towards SE side of the gas emanation site and compact basalt towards NW side. Gas emanation had occurred at the contact of these two rock types. Amygdaloidal basalt is slightly tuffaceous and highly weathered and fractured and can be broken into pieces even after applying a little pressure by fingers. The soil thickness over this rock type is about 25 ft. This rock obviously shows more porosity and is a good potential zone for groundwater. Dug wells present in this rock have ample amount of water even during summer. A vertical borehole of 50 ft depth taken in a dug well showed



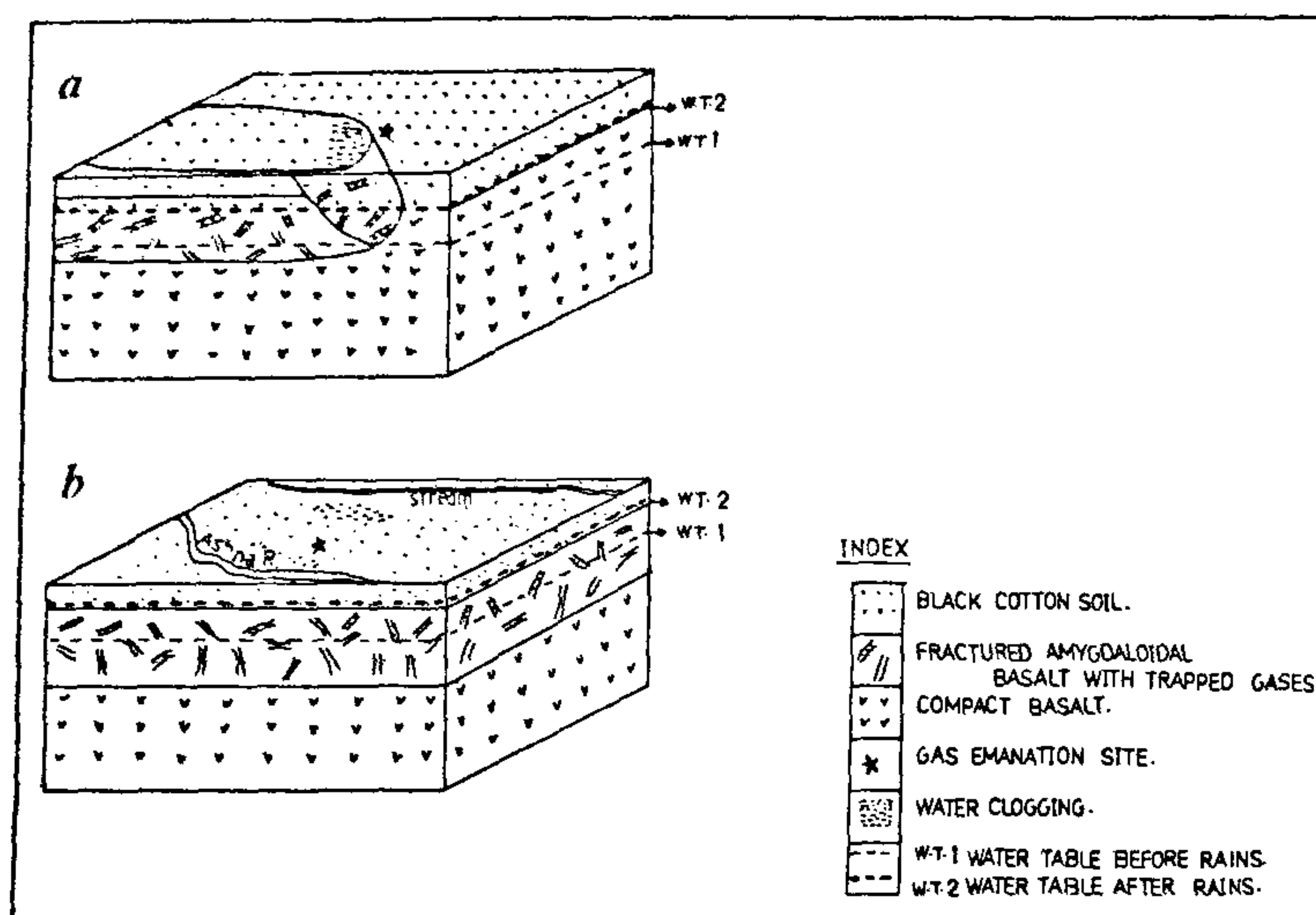


Figure 3. Explanatory diagram for the gas emanations sites (not to the scale).

fast rate of drilling and yielded good amount of water. No rock particles came out of the bore and all the material was lost in the cavities or fractures present in the highly-weathered basalt. Soil cover over compact basalt is about 60 ft. Borewell of 140 ft depth taken in the adjacent rock did not yield water (Figure 3 a).

Site 2: Gunj area is also covered by basaltic lava flows<sup>4</sup>. A basaltic flow consists of two units – a lower massive and compact basalt and an upper vesicular or amygdaloidal tuffaceous basalt. The massive basalt is dense, dark grey to black, fine grained. Amygdaloidal basalt is pinkish to reddish and contains brown volcanic glass<sup>4</sup>. At the site of gas emanations, soil thickness is about 35 ft, below which weathered and fractured amygdaloidal basalt is present. Below amygdaloidal basalt, compact basalt is present which is devoid of fractures. Groundwater occurrence is reported only from the weathered amygdaloidal basalt which is acting as a reservoir rock (Figure 3 b).

Sites of subterranean sounds/microearthquakes and ground cracks which are noticed in Marathwada region for about a month now include Daresar-sam, Bhoom, Salimba, Killari and Latur which were also reported to have suffered earlier from these types of activities in 1993 (ref. 2).

The following is the description of the sites where subterranean sounds/cracks are reported in Marathwada re-

gion for the last one month (Source: Daily newspaper *Lokmat*, *Samana*, National TV, News and Civic authorities).

1. Patoda, Bid district: From 10 to 17 September 1996 explosion-like sounds were heard (Source: Good Morning India National TV News, 18 September 1996).

2. Bendsur, Bid district: From 21 to 23 September 1996, explosion-like sounds were heard. A ground crack at the foothills was also reported.

3. Salimba and Majalgaon, Bid district: From the last few days, subterranean sounds were heard.

4. Sirsala, Bid district: A ground crack of 20 ft in length was reported from this village.

5. Nayagaon, Bid district: A ground crack 150 ft in length and 1 ft in width is reported.

6. Nagapur, Parli taluka, Bid district: From 21 to 24 September, subterranean rumbling sounds were heard.

7. Van, Parli taluka, Bid district: For the last few days subterranean sounds have been reported. Dam wall crack of about 1 km in length is reported to have a width of 1 inch and depth of about 2½ feet. Chandrashekhar, Senior Geologist, GSDA has visited the place.

8. Poharegaon, Renapur taluka, Latur district: On 28 and 29 September 1996, rumbling sounds are reported from this village. It is reported that sounds travelled from east to west. A small tremor is also felt.

9. Latur: On 14 September 1996, fire cracking sound from a well was reported to be coming out. The well was dry during summer. After heavy rains it received water and was followed by subterranean sounds.

10. Bhoom, Osmanabad district: On 21 September 1996, thundering sounds were reported, and after the sounds some houses received minor cracks and 10–12 small pits developed in this region.

11. Tuljapur, Osmanabad district: On 21 September 1996, loud subterranean sounds were heard which were followed by shattering of tin sheds and small shaking was also felt. Abnormal behaviour of pet animals was also reported.

12. Killari, Latur district: On 28 September 1996, cloud thundering-like sound was heard which travelled from east to west. A tremor was felt for 4 seconds and shattering of sheds (tin and asbestos) was reported. Similarly, adjoining villages Gangapur and AUSA in Latur district experienced a small tremor. This tremor has caused cracks and peeling of plasters from the rehabilitated houses in Killari Tanda.

13. Kawtha, Umarga taluka, Latur district: On 17 and 18 September 1996, subterranean sound was reported to be coming out from the ground nearer to the site where a 2 × 2 feet depression developed after the tremor.

14. Sonari, Himayatnagar and Daresar-sam, Nanded district: From 14 to 17 September 1996, explosion-like subterranean sounds were reported. After the sounds, shattering of sheds, peeling of plaster from walls and falling down of utensils from shelves were reported.

Marathwada region is experiencing microearthquake activity, accompanied by gas emanations and subterranean sounds. Earlier also there were reports of subterranean sounds and gas/steam emanations and microearthquake activity about two months prior to 30 September 1993 earthquake<sup>5</sup>. Gas emanations have been reported just after the earthquake on 29 August 1996 and 2 September 1996 after the region received heavy rains. Amygdaloidal basalt in this region is highly weathered and fractured and fast drilling rate and loss of material in borewell itself suggests presence of cavities and is probably the site for trapped gases. Heavy rain has resulted in the water table rising and



saturating the region with groundwater. This might have enhanced the gas eruption. The earthquake tremors received recently might have opened up the fractures and in all probability gas emanations are due to release of trapped gases in amygdaloidal basalt as a result of a microearthquake. In both the cases of gas emanation, no fractures were observed on the surface. There is probably a change in fracture porosity of the weathered and fractured basalt flows present at deeper or shallow levels caused by the tremor shaking<sup>6</sup>. Gases were coming out from small pores. Termites were also reported to be coming out during emanation and both the sites were small mounds in nature. The rise in water table might have displaced the entrapped air that would find its way up through termite burrow holes which have acted as gas outlets. It is to be noted here that near the gas emanation sites, water clogging is observed. In the absence of radon and

helium analysis, it is difficult to link these gas emanations to deep origin and it is preliminarily guessed that gas emanations at these sites are related to escape of trapped air in fractured basalt from a shallow level. The burning sensation experienced by the person might be explained by the release of injurious gas from the decay of biomass which is used in the field as fertilizers.

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## Uranium mineralization in the Palnad sub-basin, Cuddapah Basin, Andhra Pradesh, India

Recent investigations by Atomic Minerals Division have brought into focus the presence of uranium mineralization hosted in fracture zones in granite close to the unconformity with the overlying Srisailem quartzite in Lambapur area<sup>1,2</sup>, in the north-eastern part of the Cuddapah basin. Investigations further east of the Srisailem sub-basin have revealed the presence of significant concentration of uranium (up to 0.55%  $U_3O_8$  with negligible  $ThO_2$ ) in the quartzite grouped under Banganapalle Formation of Kurnool Group. This radioactive quartzite is exposed in the western parts of the Palnad sub-basin near Koppunuru, Alugurajupalle and Dwarakapuri villages (Survey of India Toposheet No. 56 P/7; 16°24'0"N; 79°20'20"E), Guntur district, Andhra Pradesh. Petrographically, the host rock is quartz arenite (orthoquartzite) with a high degree of mineralogical and textural maturity. Preliminary field data indicates that the mineralization has been influenced by major faults/fractures which facilitated the migration of (hydrothermal?) mineralizing fluids.

The main uranium-bearing minerals in this rock are pitchblende, coffinite, phosphouranylite and metazeunerite associated with sulphides of copper, lead and iron. An attempt is made in this note to bring out the salient features of this new uranium find in the Palnad sub-basin, which has

enhanced the uranium potentiality of the northern parts of the Cuddapah basin.

The Banganapalle quartzite is the oldest lithounit of the Palnad sub-basin (equivalent to Kurnool sub-basin) in the north-eastern corner of the crescent-shaped Cuddapah basin<sup>3</sup>. In this part of

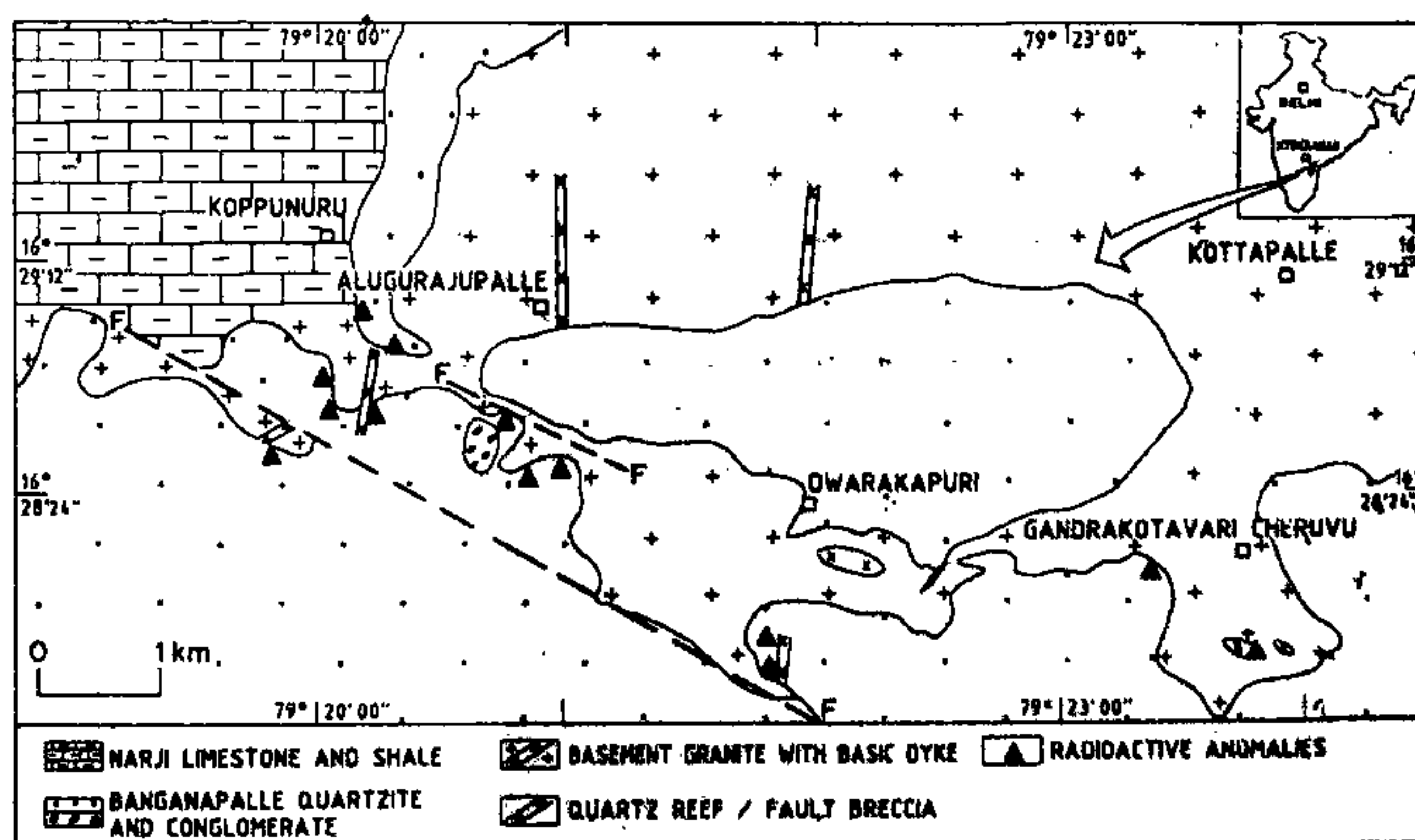


Figure 1. Geological map of Koppunuru-Dwarakapuri area.