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Response:

In our article, we had raised apprehensions about the possible spread of the algae *Kappaphycus alvarezii* in the waters of the Gulf of Mannar. In this connection it was suggested to introduce regular surveillance mechanism in the Gulf waters to keep in check the rate of encroachment of *K. alvarezii* over other native flora, so as to avoid any threat of future bioinvasion by this algae.

Tewari *et al.* have clearly indicated that they are aware of the problem and necessary surveillance mechanisms are in use for monitoring the environmental impact of large-scale cultivation of *K. alvarezii*. It appears that the institutions involved in this programme are taking adequate measures for the safety of the biosphere reserve in the Gulf of Mannar region, which needs appreciation.

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The 2005 eruption on Barren Island, Andaman Sea

The Barren volcano, the lone active volcano of the Indian subcontinent, has erupted time and again since the pre-historic period (Ravishankar *et al.*[1] and references therein). Yet the eruption is poorly documented in scientific literature. The Indian Coast Guard, Port Blair reported emission of smoke from the volcano on 28 May 2005. On 13 June, a team of geologists from the Geological Survey of India studied the nature and style of eruption and sampled the lava fragments. The activity was a continuous ejection of huge volume of juvenile gas, ash and discrete instantaneous outburst of incandescent coarser fragments of basaltic composition from a subaerial open vent. The explosion has been interpreted as mild Strombolian eruption inferred to have been triggered by the fragmentation of moderately fluid, volatile-rich, frothy magma in the upper part of the conduit but below the surface.

Barren and Narcondum on the west Andaman Sea are two volcanic islands that fall within a chain of active and quaternary volcanoes extending from Myanmar to Sumatra (Figure 1). The Barren is active while Narcondum is possibly dormant. The Barren Island exposes interstratified pre-historic lava and fragmental pyroclastics and an active volcano (Figure 2 *a*). Hobday and Mallet[2], who first prepared the topographical cum geological map of Barren Island, described 'a symmetrical central volcanic cone in the midst of an amphitheater, a summit with a height of ca. 1000 ft above msl, truncated summit marks the presence of a crater, emission of a thin column of smoke rises into the air and basaltic lavas flowing into the sea through breach on the west-

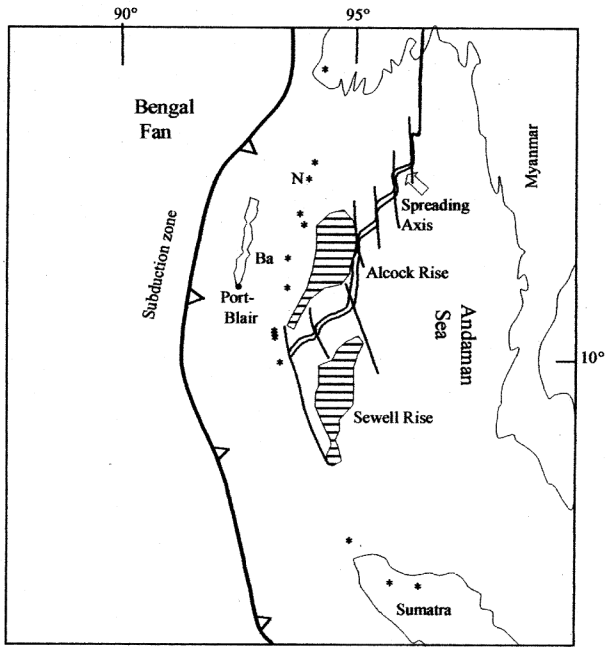

Figure 1. Location of Barren (Ba) and Narcondum (N) Islands, seamounts, spreading axis, Andaman Islands and volcanoes (asterisk) (modified after Curry[11]).

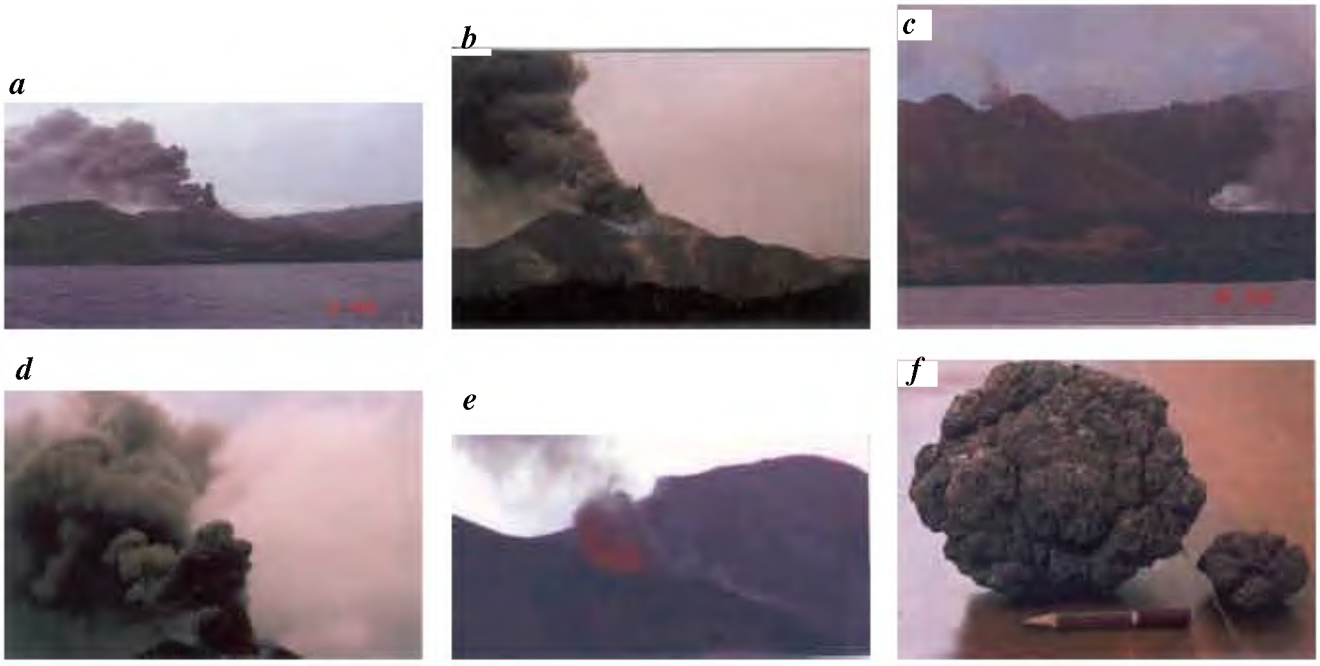

Figure 2. ***a***, Interstratified lava and pyroclastic rocks and an active volcano at Barren Island. Note drifting of smoke by wind. ***b***, Large crater area exhibiting an elongate depression extending southward and multiple saddles on the crater rim. Note the discrete, instantaneous explosion. ***c***, Initial stage of eruption showing thin column of smoke from vent and white steam near the valley. ***d***, Straight to tightly convoluted dark and dense gas thrust part above the vent overhung by lighter and less dense convective eruption column. ***e***, Transient plumes of fire showing cherry red colour. ***f***, Spherical and flattened brownish-black basaltic fragments. The outer surface has been cracked open due to vesiculation and expansion of the interior of the fragments after chilling of their surfaces. Pencil length = 7.8 cm.

ern side of the island'. Having remained dormant for more than a century, the Indian volcano exploded[3–5] in 1991 and 1995. Repeated eruptions from several vents together with collapsing, refilling and merging of vents and deposition of huge quantity of fragmental pyroclasts and lava during the 1991 and 1995 eruptions have modified the shape and size of the crater. The present crater area (Figure 2 *b*), instead of a conical to oval-shaped depression observed earlier, appears to consist of multiple depressions forming an elongated structure aligned in the north–south direction and shows saddles on the crater rim (Figure 2 *b*).

The nature and style of the present eruption was studied from the western side of the island. Coast Guard personnel noted emission of thin column of smoke from the southwestern flank of the main crater and white steam from the valley area (Figure 2 *c*). Within a fortnight, the eruption intensified (Figure 2 *a*). The eruption exhibits weak to moderately violent, discrete, instantaneous ejection of huge volume of dark grey and grey gas, mainly juvenile steam charged with ash and intermittent jets of coarser particles with a little or no melt. The activity is described as mild Strombolian eruption[6,7].

A distant view of the eruption displays emission and drifting of gas and ash by northerly blowing wind (Figure 2 *a*). A closer look from the island reveals that the almost continuous eruption of gas and ash is accompanied by discrete explosion of incandescent fragments in rapid succession (within seconds to a few minutes) from the subaerial open vent (Figure 2 *b*, *d*). The eruption forms a lofty column, reaching up to a height of about 500 m in air, showing a distinct change upwards, occasionally forming a mushroom of ash clouds over the column. The change shows that the lower part of the eruption column consists of a tightly convoluted dark eruption cloud overhung by lighter plume of cloud (Figure 2 *d*). This can be described as a lower gas thrust part and an upper part consisting of convective eruption column[8]. The gas thrust part shows jets of dense and dark gas and tephra particles ejecting out with high acceleration. The thrust height varies from a few tens of metres to hundred meters (Figure 2 *a*, *b*). The convective eruption column is less dense, lighter in colour and shows loosely convoluted eruption clouds. The discrete instantaneous explosion produces transient plumes and the cherry red colour of the plume (Figure 2 *e*) indicates 700 to 800°C temperature[6]. Fumarolic activity in the crater area shows phreatic eruption of white steam generated by heating of surface or groundwater external to the magma (Figure 2 *c*). While the finer ash particles are drifted away by the wind, the coarser ones show explosive ejection with ballistic trajectories; these are unaffected by the wind. They represent ballistic clasts[9].

The eruptive products as air-fall deposits roll over the craggy slopes of the volcano and adjacent cinder cone and get mixed with already deposited loose pyroclastic debris. They consist of red-stained granule, pebble and cobble size fragments of basalt; a few appear to be of boulder size. A few fragments show spherical and somewhat flattened shape and cracked surfaces (Figure 2 *f*). The fragments are partly crystallized and show white feldspar phenocrysts set in black basaltic groundmass. Petrology in detail does not show any essential difference with that resulted from previous eruptions[4,5].

The mild Strombolian eruption of this sort indicates that volatile-rich, moderately

fluid frothy magma rises and stands at high level in the conduit, but generally below the surface[7]. Due to the greater viscosity of the moderately fluid magma, gas escapes less readily from it than in the case of fluid magma of Hawaiian activity. During the rise and temporary stay of the magma at shallower level, this obviously allowed rapid formation of separate gas phase, accumulation of gas-bubbles, expansion of bubbles and in turn fragmentation of frothy magma resulting in explosion and ejection of clots of solid and partly molten fragments of lava and magmatic gases. The gas thrust part indicates rapid decompression of the gas phase, whereas the overlying eruptive column indicates incorporation of atmospheric air into the decelerating and less dense eruption clouds higher up in the atmosphere[9]. The phenocryst-rich fragments indicate that the magma was in an advanced stage of crystallization[10]. The spherical fragments possibly achieved roundness during travel in the air. Thus they appear to be partly molten and in turn a product of volcanic action and not of the disruption during eruption[9].

The Andaman Sea represents a back arc basin formed by transtension[11] and lies along an oblique convergent margin showing deformation and destruction of the Indian plate below Burma microplate along the Andaman–Java subduction. Dasgupta and Mukhopadhyay[12] showed a seismic gap between 90 and 100 km depths in the Andaman Benioff zone and its spatial relation with volcanism on Barren Island. This gap implies partial melting of the Indian oceanic lithosphere under upper mantle condition and generation of magma for the current Barren eruption. Partial melting and dehydration of the ocean floor sediments and serpentinite (dehydrated peridotite) possibly produce the hydrous basaltic magma rich in dissolved H_2O and CO_2. Due to its lower buoyancy, the magma moves upward and under rapid decompression at shallower level of the crust is changed into a volatile-rich frothy magma subjected to explosive fragmentation from a subaerial open vent.

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NEWS

Self-employment for self-sufficiency

India is a vast country (3,287,240 km^2 area) supporting a population of more than 102 million. This population pressure is increasing at an alarming rate, resulting in unemployment in the society.

To help unemployed youths become self-sufficient, there are several self-employment opportunities.

Detailed information on the uses, requisite raw materials, capital investment, etc. can be obtained from various departments of State governments like rural development, industry, fishery, agriculture, etc. The Council of Scientific and Industrial Research, Central Drug Research Institute, Central Leather Research Institute and many other institutes also provide schemes towards self-employment at the national level. Some of the departments also provide loans to interested beneficiaries and thus one can become self-sufficient by setting up his/her own factory. However, there is a need for awareness and dissemination of information on such self-employment opportunities through various mass media, among the unemployed youths.

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