related to the magnetic fraction. In addition, it depends on the composition of the magnetic minerals, nature of magnetization, domain states, the number of domains aligned along a common direction etc. It may possibly be the vector sum of many components of magnetization acquired at different times. But its dependence on magnetic fraction (Figure 3 *b*) leads one to infer that a large part of the magnetization is viscous (VRM) or isothermal (IRM) in nature. The Q_n values, which are sometimes used to assess magnetic stability, seem to corroborate this inference. The values of all the rock types are in the same broad range with a lognormal and unimodal distribution. This is consistent with the fact that magnetizations are controlled by minerals of the spinel group only. The average values of all the rock types (Table 1) are less than 0.5. Rocks with such values are dominated by MD (multi domain) grains[19]. The protores under study are coarse-grained with grain sizes of 2 mm or more being common[14]. The other rock types are the altered products of protore or paragneisses. From these considerations, the magnetizations in all the rock types seem to be soft. Such natural remanent magnetizations are not likely to be much different in direction from the induced magnetization. Direction of the latter normally coincides with that of the ambient geomagnetic field. These inferences lead to the conclusion that the contributions of these two components of magnetization to the magnetic anomalies are likely to be complementary to each other. Differences in magnetic properties caused by differences in the concentration of magnetic minerals are indicative of the extent of leaching and oxidation in these rock types rather than their original composition.

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Occurrence of monazite in some alluvial soils of North Bihar

J. Mall and B. B. Mishra

Soil Survey and Land Use Planning Scheme, Sabour,
Bhagalpur 813 210, India

Monazite, a thorium-bearing mineral, has been identified in the heavy mineral fractions of the fine sands from the alluvial soil profiles at Barpalia and Gyaspur of Siwan district in north Bihar. The amount of monazite varied from 14.29 to 15.40% and 6.25 to 9.38% of the heavy minerals in the fine sands of Barpalia and Gyaspur, respectively. Monazite could have been derived from the granite pegmatite and gneissic metamorphic rocks in association with feldspar, zircon and apatite from the Himalayan orogan. The amount of ^{232}Th present in monazite originally ranges from a few wt% ThO_2 to 10–12%[1]. Even in the east coast of India, monazite contains 9.05% ThO_2.

MONAZITE, a (Ce, La, Th) (PO_4), occurs only in the finer fraction of the sediments[2]. Compared to Kerala coast[3], Chilka lake coast contains monazite only in a small amount (0.16–0.88%)[2] in the heavy minerals of the fine sand fraction. Even in the east-coast, its percentage in the coastal sediments was estimated to range from 0.5 to 3.0% (ref. 2), while in the Travancore coast, its percentage was as high as 10.22% (ref. 1). Although thorium is present in monazite in substitution for cesium and lanthanum, thorium-free monazite is rare[1]. It is, moreover, observed that the intensity of radioactivity is proportional to the average monazite content and the level of radioactive intensity in the region may be due to occurrence of monazite even in traces. The present investigation was accordingly undertaken to identify the presence of monazite in some alluvial soils of the Indo-Gangetic plain of north Bihar quantitatively. No data on these aspects for all alluvial soils, particularly of north Bihar, are available. However, in India, monazite is known to occur in Travancore, Gaya and Ratnagiri[1] besides coastal sediments near Chilka lake[2].

Table 1. Relative amounts of light and heavy minerals in fine sand

	Barpalia				Gyaspur			
Soil profile	Fine sand in soil (%)	Light mineral (%)	Heavy mineral (%)	Ratio (L/H)	Fine sand in soil (%)	Light mineral (%)	Heavy mineral (%)	Ratio (L/H)
Upper	75.70	87	13	6.69	88.90	68	32	2.12
Middle	44.00	86	14	6.14	66.80	84	16	5.25
Bottom	60.40	80	20	4.00	79.20	76	24	3.17

Table 2. Individual minerals in heavy fraction of fine sand (per cent)

	Barpalia			Gyaspur		
Heavy mineral	0–15 cm (upper)	66–116 cm (middle)	155–175 cm (bottom)	0–12 cm (upper)	67–110 cm (middle)	149–185 cm (bottom)
Biotite	15.40	14.29	10.00	25.00	18.75	20.83
Chloritized mica	15.40	14.29	10.00	–	–	–
Zircon	–	–	–	9.38	6.25	8.34
Garnet	29.00	28.57	20.00	9.38	12.50	8.34
Monazite	15.40	14.29	15.00	9.38	6.25	8.34
Rutile	7.70	7.14	5.00	–	–	–
Opaque minerals	15.40	21.42	40.00	40.62	43.75	45.83
Apatite	7.70	–	–	3.12	6.25	4.16
Sphene	–	–	–	3.12	6.25	4.16

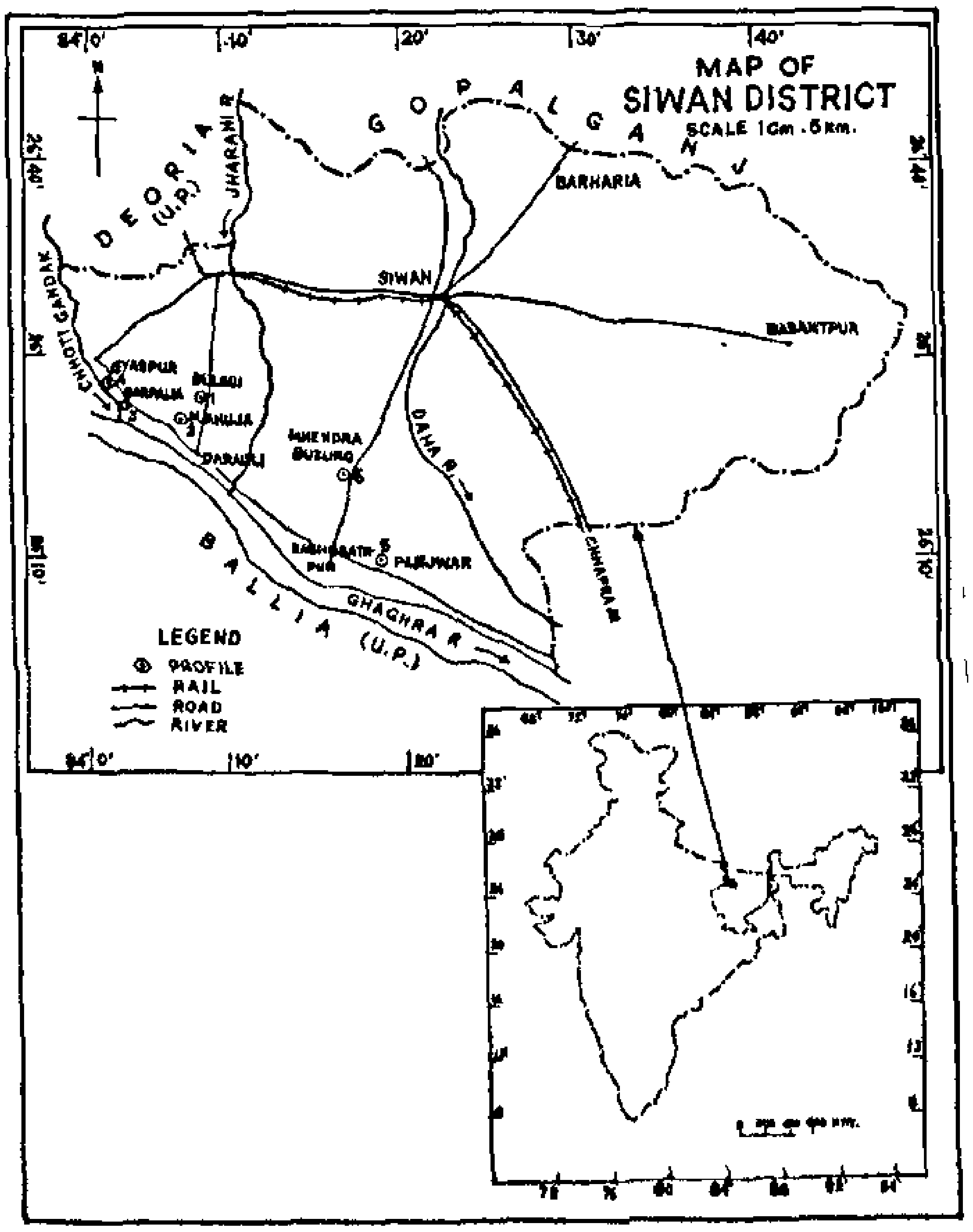

Figure 1. Map of Siwan district

Out of the six soil profiles[4] studied in Siwan district of north Bihar, only two profiles located at a distance of about 4.5 km indicated the occurrence of monazite in varying amounts (Figure 1). Profile 3 (fine, mixed, hyperthermic *Udic Haplustalf*) was located at Barpalia, about 6 km south-east of Guthani and profile 4 (fine loamy, mixed, hyperthermic *Ultic Haplustalf*) at Gyaspur, about 2 km south of Guthani. Soil samples from upper, middle and bottom layers of varying depths in both profiles were collected, air-dried and processed for mechanical separation of fine sand fractions (0.2–0.02 mm) from bulk soils by dry sieving. The heavy and light minerals in the fine sand fractions were further isolated by using bromoform (sp. gravity 2.98 g/cc). The heavy minerals were identified by petrological microscope and their percentage was computed for relative quantification of the minerals.

The percentage of both light and heavy minerals in the fine sand fractions of the respective soils of Barpalia and Gyaspur and their ratios are given in Table 1. However, data in Table 2 indicate the relative percentage of the individual minerals in the heavy fractions of the fine sand in respective soils. The heavy fraction of profile 3 (Barpalia) contains biotite, chloritized mica, garnet, rutile and opaque minerals whereas profile 4 (Gyaspur) contains biotite, zircon, garnet, opaque minerals, apatite and sphene in appreciable amounts. These two profiles invariably indicate the occurrence of monazite in varying amounts. The heavy fraction in profile 3 contains monazite ranging from 14.29 to 15.40% while in profile 4, its values vary from 6.25 to 9.38%. The amount of monazite present in the heavy minerals of Gyaspur is comparable to its values in Travancore[1]. Moreover, its values for Barpalia are slightly higher. The values of monazite would have, however, been much lower, if computed for the bulk of sand and soil mass, since their heavy mineral fractions constitute only 13–32% of the fine sand in the soils of both the profiles (Table 1).

These soils are derived from alluvium in the Indo-Gangetic plain of Bihar and the deposit of alluvium is affected by Ghaghra and Chhoti Gandak rivers (Figure 1) emanating from the Himalayas. The chief rock types of the Himalayan series include quartzitic sandstone, slate, limestone, schist, conglomerate, granite and gneiss. The light minerals in the fine sand include quartz, feldspar and muscovite in abundance[4]. Monazite may occur in granitic pegmatite[5] and gneissic metamorphic rocks[1] in association particularly with feldspar and with zircon and apatite[5].

It is concluded that monazite present in the fine fraction of some alluvial soils in north Bihar is considerable not only from the pedological point of view, but its occurrence in such quantities should be of interest to geologists, radiologists as well as health physicists. As such, further investigation is desirable.

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Nitrogen dynamics of actinorhizal *Casuarina* forest stands and its comparison with *Alnus* and *Leucaena* forests

R. S. Ambasht and Alok K. Srivastava

Department of Botany, Banaras Hindu University, Varanasi 221 005, India

***Casuarina equisetifolia* (Forst. & Forst.) plantation forests of 5 yr and 8 yr age in dry tropics of Shaktinagar, Sonebhadra in Vindhyan plateau were studied for N cycling through vegetation, litter and soil pool and compared with similar work on subtropical actinorhizal *Alnus nepalensis* and tropical rhizobial *Leucaena leucocephala*. Interannual variation in nitrogenase activity was observed with a maximum in July–August while peak N-accretion was in September–October. N input through foliage litter accounted for 85–95% of total litter N, of which 90% was released through decomposition in one year, whereas in *Alnus* only 60% of the litter N was annually released. The contribution of biological N_2 fixation to total N uptake was maximum in *Casuarina* (37%) followed by *Alnus* (33%) and *Leucaena* (16%). It has been concluded that *Casuarina* successfully covers the thin soil profile of freshly degraded Vindhyan hills and restores the soil N fertility.**

RAPID deforestation has accelerated savannization and desertification. Afforestation by fast-growing, preferably N-fixing tree species has been attempted at several places in the tropics and subtropics. In tropics, such species are mostly *Rhizobium*-nodulated leguminous trees[1] while in the temperate region, *Frankia*-nodulated non-leguminous actinorhizals[2] are of importance. However, *Casuarina*, which is an actinorhizal species bearing *Frankia* as N-fixing symbiont in its root nodules[3], is predominantly tropical and capable of growing on nutrient poor[4] and coastal sandy saline soils[4].

Nitrogen plays a key role in soil fertility and plant productivity and often poor productivity is due to its deficiency in soil[5]. Root nodules not only fix and transfer nitrogen to plants, but also enrich soil fertility on its decomposition. Nodules are short-lived and have a rapid cycle of formation, growth, death and decay[6]. Litter decomposition rate is usually faster in tropical, warm and moist condition than in subtropical, less warm and moist condition[7,8]. Therefore, it is of interest to compare an actinorhizal tropical species *Casuarina equisetifolia*, which we have presently studied, with the earlier studies of Sharma and Ambasht on subtropical actinorhizal *Alnus nepalensis* trees[9–11]. These actinorhizal trees are also compared with a tropical rhizobial tree *Leucaena leucocephala*, introduced in India on large scale, studied by Sandhu and coworkers[12,13]. Such a comparison would help in policy decision for afforestation and restoration strategies and rehabilitation of deforested landscape.

Plantation of *C. equisetifolia* (Forst. & Forst.) has been done by the forest department at Shaktinagar in Sonebhadra district of Vindhyan plateau (24°–24°–12' N, 82° 40'–82° 44' E), central India. Two age class stands available there were of 5-years and 8-years (December 1988 census) with the tree densities of 3500 and 666 trees/ha in the respective age classes. Both these stands were selected for our studies. The trees had an average height of 8.6 m and 16.0 m with maximum