Selective sand samples were collected from Gopalpur and Paradeep beaches and studied for their heavy mineral assemblage. Beach sands of both the areas contain heavy minerals like sillimanite, ilmenite, garnet, pyroxene, rutile, sphene, biotite, hornblende, zircon and monazite. At Gopalpur, the percentage of concentration of sillimanite is the highest followed by limonite, garnet, pyroxene, rutile, sphene, biotite, hornblende, zircon and monazite. At Paradeep, almost similar trend was observed with some exceptions, i.e., concentration of pyroxene and biotite is more here. The mineral sphene was absent at Paradeep, whereas tourmaline was negligible at Gopalpur. Higher grade percentage of heavies at Gopalpur is linked with many favourable factors and is being mined by IREL whereas low grade percentage at Paradeep discourages mining.

Key words: Beach sands, Gopalpur beach, heavy minerals, Orissa, Paradeep beach

The state of Orissa is one of the important littoral states of the eastern sea board due to concentration of heavy minerals at different places particularly from the south of Mahanadi mouth to Orissa–A.P. border. Atomic Minerals Directorate for Exploration and Research (AMD) of the department of Atomic Energy is exploring and assessing the potential of the Orissa beach placers since 1958-59. The exploration work was mostly confined to southern Orissa coast, between Orissa-Andhra Pradesh state border and Mahanadi delta. A number of potential fields have been discovered between Rushikulya river in north and Pedda-lakshmpuram village near Orissa Andhra border in the south cover a distance of 43 km. Of these, the northern 18 km long stretch between Rushikulya river and Gopalpur town is known as “Chatrapur Mineral Sands Deposit”, currently being explored by Indian Rare Earth Limited (IREL). The occurrence of coastal sand dunes containing monazite, zircon, ilmenite, rutile, and sillimanite in south Orissa on the east coast of India, especially along Ganjam coast is known since a long time. Recent work along Puri coast has identified wider sand bodies with significant heavy mineral concentration, which requires detailed exploration for their heavy reserve potential.

The purpose of the present paper is to study the heavy minerals of Paradeep and Gopalpur beaches and assess the economic viability for mining at Paradeep. (Fig.1). The area under study is a part of coastal tract of Orissa around the village Gopalpur (Fig.1). Sand samples, about 2 kg by weight were collected from Gopalpur and Paradeep sea beaches. Twelve samples each were collected from Gopalpur and Paradeep covering a distance of about 6 km. The sampling points were located at an interval of

Fig. 1 — Map showing the study area and coastal segments of the Orissa coast
500 m. A hand operated sand augur having one and a half inch diameter was used to collect the samples. Collection of the samples was done in the pre-monsoon period, i.e. in the month of May, 2001. In both the beaches the samples were collected mostly from the back shore region from a depth of 0.75 m. Each sample was washed and exposed to sun for six hours and then dried up in an oven at 200°C for two hours. The samples were sieved through a set of ASTM sieves having numbers +60, +80, +120, +170 and +230 followed by standard bromoform separation technique4. All the size fractions of 60, 80, 120, 170 and 230 sieve samples were subjected to bromoform separation. The coarser fractions 60, 80, 120 did not yield any heavy mineral concentration whereas the finer fractions of +170 and +230 yielded heavy minerals. Slides were prepared from +170 and +230 fractions and point counting was done. About 300 grains in each slide were identified and counted using the line method5. The number percentage of each heavy mineral was then computed and converted into weight percentage by multiplying with the specific gravity of the respective minerals.

The study of minerals of +170 fraction of Gopalpur (Chatrapur) by point counting indicates that minerals like sillimanite, ilmenite, garnet, pyroxene, rutile, sphene, biotite, hornblende, zircon and monazite were found in order of decreasing abundance (Table 1). The heavy minerals of Paradeep are very much identical to that of Gopalpur. The heavy mineral concentration (wt %) in +170 size fractions varies from 0.44 to 2.92 %, in +230 fractions varies from 0.23 to 2.15 % and total weight percentage varies from 0.25 to 4.42 % at Paradeep beach after bromoform separation. The average comes around 2.23 % which does not seem to be promising for mining. From this result it is found that costly heavies like ilmenite and monazite occurring as 18.94 (wt %) and 0.59 (wt %) respectively give some hope for mining in future. However a detailed study over a long stretch of beach covering large area may bring some conclusive and positive result.

Mineralogical assemblages in beaches vary from one region to another depending on a number of factors like host rocks in their provenance, climatic conditions prevailing in the area, agents and mechanism of transport and hydraulic conditions during deposition6. The sediments that are delivered into the sea by the river will be redistributed by the waves and currents according to their densities, size and shape7. The concentration of heavy minerals depends on the hydrodynamic conditions like sediment influx from the hinterland, wave energy and its velocity, long shore current and wind speed which control littoral transport, sorting and deposition of placer minerals in suitable locales1. In present case mostly aeolian and marine actions have played a significant role and the shape of coastal geomorphology have played important role in the concentration of heavy minerals. The distribution pattern exhibited by ilmenite, garnet, sillimanite and pyroxene suggest that differences in specific gravity, settling velocity and differential transport have played a major role in their distribution7 at Gopalpur and Paradeep.

The heavy minerals of both the beaches have been derived from the same Eastern Ghat Group of rocks comprising granites, gneisses, and metasediments of Archaean to Proterozoic age and Gondwanas exposed in the hinterland1. The coast between the Devi river in the south to the Mahanadi river in the north forms the Paradeep sector with deltaic sediments of the Mahanadi river system. The coastal area is low lying and marshy with mangrove forests and traversed by numerous back water channels and lagoons. Wider sand bodies are found both in the barrier beach and along western margin towards inland1. Mahanadi delta is a composite prograding delta. Three major generations of deltaic sediments have been mapped8 from the lower portion of Mahanadi. These deltaic sediments are underlain by Gondwana sediments and have a minimum thickness of more than 2400 m and 2000 m near Konark (mouth of Devi river) and Paradeep respectively9. Eleven abandoned delta lobes and three strand lines have been identified in coastal plains of the Mahanadi delta10. The poor presentation of beach ridges has been attributed to dominant
fluvial action. Delta progradation has resulted recession of sea with development of a number of palaeo-strand lines deep inland. A number of palaeo-sand ridges of 10-15 km inland from present day shore lines is seen above the cultivated land attaining heights of more than 10 m.

Atomic Mineral Division’s survey of some palaeo-sand ridges showed heavy mineral grade range between 2 and 64% (average 16.47%). However, the present study area in Paradeep beach does not show promising result. A detailed study for a long stretch of beach is required before commenting on the economic viability for mining. The minerals are mined at Gopalpur (Chatrapur) by Indian Rare Earth Ltd. (IREL) because of high concentrations of sillimanite, garnet, rutile, ilmenite and monazite but the heavy mineral deposits on the study area do not seem to be promising.

References
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