Coastal Placer Mineral Evaluation using GIS Approach: A Case Study at Kallar Vembar Coast

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SUMMARY

The deposits along the coastline between Kallar and Vembar are well-disposed long continuous beaches throughout the coastline. The shorelines of these areas have been experiencing both accretion and erosion. The beaches have enriched with economic minerals such as ilmenite, garnet and zircon. In the present study focused on Beach Placer mineral deposits along the beach profile represented three dimensional perspectives views. More over, the studies of grain size, heavy minerals and beach profile variation have led to evaluate the placer potentiality in this region. The integration of mapping and database through Arc GIS allows us to identify and analyse the possible correlation between the variables of heavy mineral placers in that location. Data of beach profile, grain size and heavy mineral values are displayed in the form of polygon and buffer to show the relationship among them.

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1. INTRODUCTION

The Indian coastline of 6500 km stretch is marked by accumulation of various types and grades of placer deposits .In the west coast, beach placers have been reported in Kerala(Prabhakara Rao,1968) and Ratnagiri(Mane and Gawade,1974).The well known occurrences in the east coast are near Visakapatnam in Andhra Pradesh (Sastry et al,1987), coastal areas of Orissa and buried placers south of Chennai(Mohan and Rajamanickam,2000).In Tamilnadu, Chandrasekar(1992)reported that the Coastal stretch from Nagore to Tirumullaivasal is rich in zircon, garnet and kyanite.Loveson et al (1996) delineated many strike slip faults formed by neotectonic activity that resulted in physiographic lowlands between Kanyakumari –Kuttankuli and Sippikulam-Kannirajapuram suggested that these lowlands acted as controlling factors for the segregation of heavy minerals. During the last decade significant advances have been made in the beach placer exploration in our country. These quantities have to be gathered in GIS as point information, profiles over the vertical and fixed locations, and over cross sections. This is very much needed for mining industries for generating a huge exploration and exploitation .In the present scenario such informations are sought by government, academicians, public and industries. Therefore the paper is attempted to differentiate the regional beach placer occurrence along the coast using Arcview GIS.

2. STUDY AREA

The study area is bounded latitudes 08’.58’’- 09’.00’’N and 78’. 13’’ to 78’. 17’’E and total shoreline length is about 12 km. This coastline was formed by sediments carried out by small rivers and recycled sediments of waves and currents. Most of the beaches of this region are sandy form with mud in the vicinity of the small rivers such as Kallar, Vaippar and Vembar. A pocket of beach rocks is noticed here and there in the coastline. Southwest and northeast monsoonal waves and littoral currents have played major role on changes in the shoreline configuration.(Fig.1.Location map).

3. MATERIALS AND METHODS

The sediment samples were collected from berm, high, mid and low tides region using an auger of 2m length. The bulk samples, after drying were reduced to 100gm by coning and quartering. Carbonate, Organic matter and ferruginous coatings were removed from the samples by treatment with 1:10 HCl, 30% by volume H_2O_2, HNO_3 and $SnCl_2$, respectively. The sieved materials were collected and weighed. The textual analysis has been attempted for the sieved and weighed materials to understand the grain size distribution. The sieved fractions from +45 to+270 mesh sizes were used for heavy mineral separation following the procedure described in Milner(1962). The seasonal beach profile data were collected along this coastline. The beach profiles were measured on the low tide using standard survey techniques for bench marks out to waiding depths .To create thematic map of beach profile we were able to utilise mean annual beach change rate information related to changes on heavy mineral distribution. GIS used in the present study is ArcGIS. The base map was prepared, and the coastal boundary and drainage features were extracted from Survey of India topomaps on 1:50,000 scales. This traced map was scanned and imported into ARCINFO. These features were digitized through online digitization .The digitized data was converted to UTM projection, and was exported to Arcview shape file. Based on the mapping requirement the information on grain size, numerical beach profile value and heavy mineral data were created from RDBMS file system (Getis and Ord,1992).In order to predict the concentration of heavy mineral and its relationship between sediment size and other variables, an integration of polygon processing and proximity analysis were carried out.(Pereira and Itami,1991)

4, RESULTS AND DISCUSSION

Heavy mineral distribution, grain size data and beach profile data were given in the Table1, 2 and 3.These data have also been presented in the form of 3D perspective nature. The distribution of beach placer mineral (garnet,ilmenite,zircon) concentration on different beach profile environment (Berm,High tide ,Mid tide and Low tide level) are represented in the form of TIN surface model shown (fig 2 ,3)In addition Simple buffering and polygon analysis have performed to highlight the occurrence of heavy mineral distribution in the beaches. Polygon area gives us some quantitative measure of the amount of each classified areal feature. In the area of particular polygon, whether or not it constitutes contiguous deposits, need to isolate each polygon separately by selecting its grid cells and reclassifying them. So that their attribute values are unique to the coverage of the coastline. It was also found that this sediments cover within the tidal limits was more useful to predict the linear change in concentration of heavy minerals in a seasonal form. The concentration of heavy minerals decrease substantially within the intertidal zones. The intertidal sediments exhibit well-defined mineral layering with heavy mineral lamination comprising between 2 to 18m width of the tidal zones and the zone of mineralisation has been demarcated using proximity and polygon analysis (fig.4).

In that case the buffer is selected not on the basis of an arbitrary value nor of a poorly know friction value. The measurements are not arbitrary here but are quite accurate which is mainly based on measurable phenomena in GIS analysis. Erosion process was dominant during post monsoon due to the changes in cycles on waves and current direction. The rate of erosion of coastline was found to be 6m to 9m/year. Similarly the rate of accretion was found to be 10.5 to 45 m/year. Mostly accretion occurred near groins and river mouths. The erosional area is the prominent location for the concentration of heavy minerals in the study area (Chandrasekar et al, 2002). The seasonal heavy mineral concentrations are shown in the Table1.The highest heavy mineral concentrations are noticed during monsoon. However the entrainment and selective sorting process led to the entrainment of heavy minerals during post monsoon. In order to distinguish the variation in Arcview GIS the relationship between heavy mineral, grain sizes and beach profile was designed with all basic information related to heavy mineral variation is accessible on click of mouse on thematic information maps. The proximity analysis and polygon processing have clearly demonstrated the enrichment of heavy minerals along the beach corridor because of its proximity to features identified by the extraction, example within 18m of heavy concentrations availability in particular locations.

5. CONCLUSION

The occurrences of heavy minerals were demarcated using buffering and polygon processing in Arcview GIS. This has some limitation in differentiating heavy mineral content within the tidal zones. Efforts being taken on various parameters (grain size, profile area, heavy mineral content) produced through transformation should be merged into a single theme to represent those areas for placer mining.

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REFERENCES

Chandrasekar,N.,1992. Beach placer mineral exploration along the Central Tamilnadu Coast. Unpublished Ph.D.thesis, Madurai Kamaraj University, Madurai.

Chandrasekar, N., Anil Cherian, Rajamanickam, M. and Rajamanickam, G.V.,2002. Temporal and spatial relationship between beach profile and heavy mineral concentration along the coast of Kallar and Vembar, Tamilnadu. Proceedings of national seminar on Exploration, Mining and Processing of beach placers in India (In press).

Getis, A. and Ord, J., 1992. The analysis of spatial association by distance statistics. Geographical Analysis. 24, pp 189-205 John, D.B, John, R.J, Robert B.M and Chris Rizos.,2002 Manual of Geospatial Technology. Taylor & Francis publication, London, pp.411 – 430.

Loveson,V.J., Angusamy, N. and Rajamanickam, G.V.,1996. Usefulness of identifying different geopmorphic blocks along the coast of southern Tamilnadu. Indian Jour. Of Geomorphology, 1(1), pp 97-110.

Mane,R.P. and Gawade,M,K.,1974. Reports on prospecting of ilmenite beach sands of Ratnagiri Dist. Unpublished Report No.145.Directorate of Geology and Mines, Government of Maharastra, Nagpur, India.
Milner,H.B.,1962 Sedimentary Petrography. George Allen and Unwin Ltd, London.
Mohan,P.M. and Rajamanickam,G.V.,2000 Identification of coastal placer deposits along the coast between Madhuranthagam and Madras. Unpublished Technical Report, Dept. of Science and Technology, New Delhi.
Pereira, J.M.C. and Itami, R.M., 1991 GIS-based habitat modeling using logistic multiple regression: a study of the Mt. Graham red squirrel Photogrammetric Engineering & Remote Sensing, 57(11), pp 1475-1486.
Prabhakara Rao,G.,1968 Sediments of the nearshore region off Neendakara, Kayamkulam coast and Ashtamudi and Vatla estuaries, Kerala, India. Bull. Nat. Ins. Sci. India, 38 pp.513-551.
Sastry,A.V.R., Samy,A.S.R. and Vasadev, K., 1987. Heavy minerals of beach sands along Visakapatnam-Bhimunipatnam, east coast of India. Indian Jour.Mari.Sci., 6,pp 39-42.

Station	Pre-monsoon	Monsoon	Post Monsoon
Vembar	59.92	55.42	52.26
Pachayapuram	63.09	63.09	65.82
Periasamypuram	70.69	73	69.81
Kalaignanapuram	65	78.07	63.59
Sippikulam	28	34.63	34.09
Kallar	31.38	37.87	34.93

Table 1. Seasonal heavy mineral variation in the study area (wt %)

Station	Pre-monsoon	Monsoon	Post Monsoon
Vembar	1.74	1.26	1.15
Pachyapuram	1.64	1.2	1.14
Periasamypuram	1.9	1.84	1.18
Kalaignanapuram	1.98	1.03	1.11
Sippikulam	1.85	1.18	1.28
Kallar	1.07	1.12	1.13

Table .2. Seasonal grain size variation in the study area (phi)

Station	Pre-monsoon	Monsoon	Post Monsoon
Vembar	611.45	730.76	837
Pachyapuram	449.6	437.96	365.7
Periasamypuram	431.93	448.82	383.31
Kalaignanapuram	363.28	311	348.56
Sippikulam	418.19	360.45	372.43
Kallar	292.28	279.88	259.43

Table 3. Seasonal variation on beach profile area in the study area (m^2)

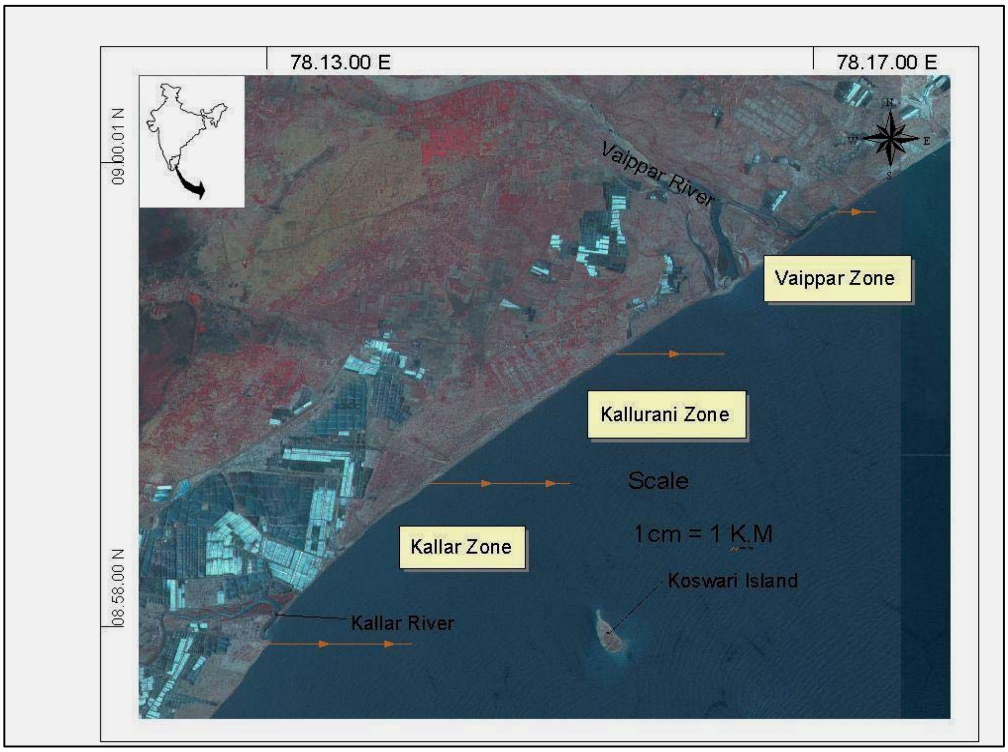

Fig.1.Location map of the study area

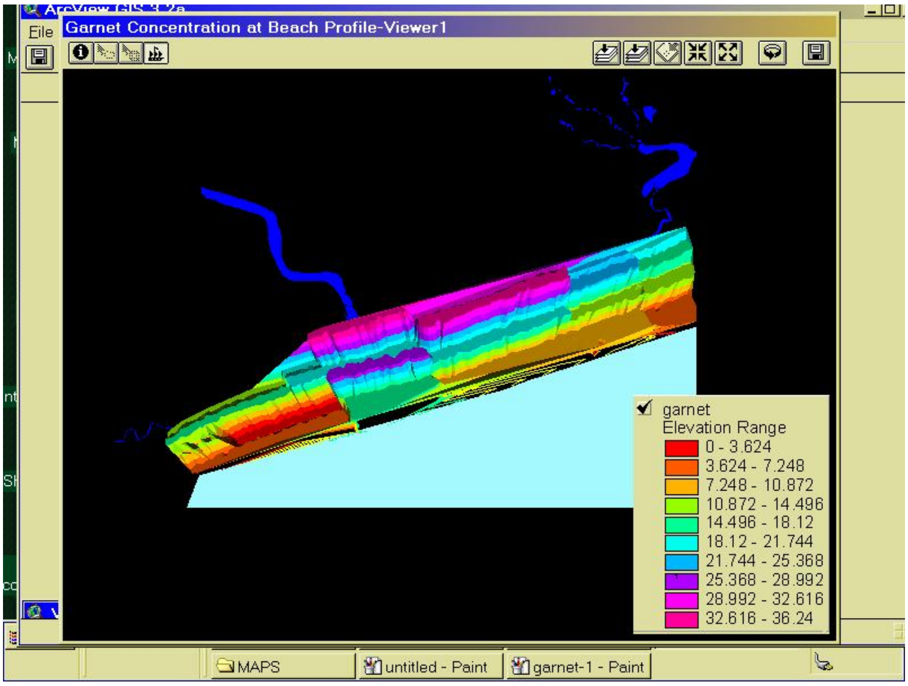

Fig.2.Garnet concentration shown in TIN Model at beach profile

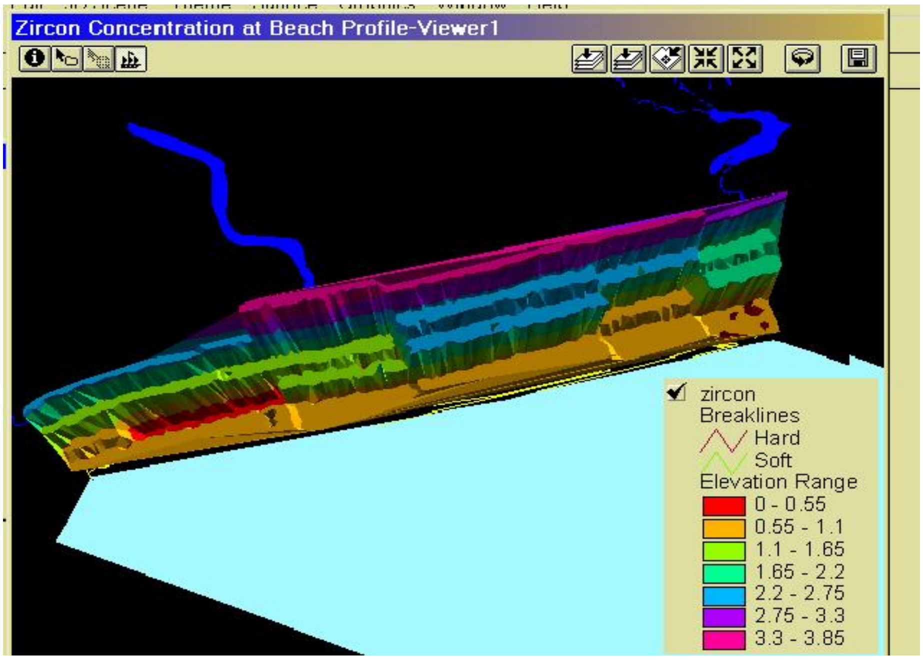

Fig.3.zircon concentration shown in TIN Model at beach profile

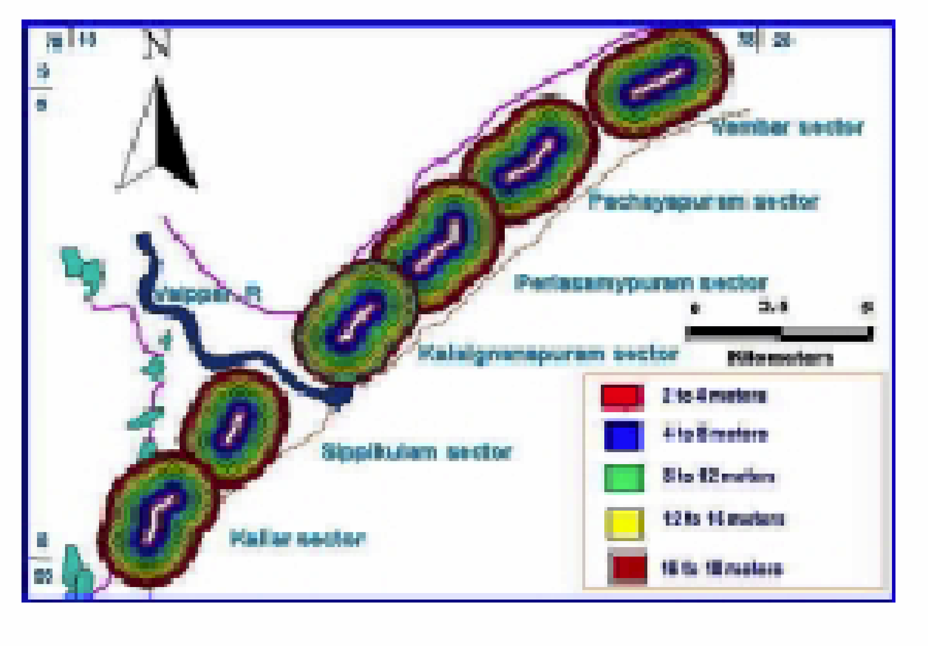

Fig.4. Buffer showing the heavy mineral distribution pattern in the study area

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