Interpretation of Aerial Photographs of Ratnagiri Bay—A Case Study

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Aerial photocharacteristics like tonal differences, texture, shape, size, form, pattern, vegetation, soil characteristics and associated features were used to identify fluvial, marine and aeolian features such as tidal flats, mesas, wave-cut platforms, beach ridges, dunes and sand bar in Ratnagiri bay. Important coastal and nearshore submerged features were correlated with ground truth data.

Coastal and nearshore geomorphological investigation of the central west coast of India is being carried out to understand the Quaternary history of the coastal areas and its relationship with the development and sedimentation of the shelf. In this paper, application of aerial photo-interpretation techniques for the geomorphological study of Ratnagiri bay is discussed.

Methods
A loose uncontrolled photo-mosaic of the study area has been made to study visually the coastal and nearshore features, then detailed scanning of each and every photograph (scale, 1:25,000 approx.) has been carried out with the help of photo-recognition and terrain elements. The geomorphic details are transferred on kodatrace and later compiled in a map (Fig. 1).

Results and Discussion
Ratnagiri bay (16°58'N, 73°17'E) forms part of the Konkan coast along the central west coast of India. It is 3 to 4 km in length (at the mouth) and has about 2 km width. Towards the northern and southern sides the bay is well marked by flat topped rocky (laterite capped) promontories of about 80 to 100 m height. Geomorphological features of Ratnagiri bay interpreted from aerial photographs are given in Fig. 1. The most prominent features of marine erosion seen are cliffs, sea stacks and nearly horizontal abrasion platforms. Ground truth indicates that the cliffs range in height from 5 to 50 m and have been formed by undercutting and subsequent fall of large rock masses.

The river Kajvi enters the bay at its southern end. It originates from the Sahyadri ranges and its longitudinal profile attains base level of erosion within a very short distance from the Ghats. Tributaries are still youthful and due to heavy rainfall cause a tremendous headward erosion. For a considerable distance the river runs almost in the E-W direction but towards the coast it takes sudden diversion towards NW or NNW direction. The sudden change in the course of river Kajvi, is apparently controlled by NNW-SSE trending linears. In the area north of Ratnagiri, satellite imagery interpretation revealed that the junction of major rivers with their tributaries are anomalous.

Towards the mouth the river being very shallow aerial photographs reveal the thick sediment covered flat bottom topography. Presence of numerous point bars and channel bars in the channel indicates the migration of the river. Shallow seismic data off this river indicate that towards offshore bedrock is uneven with eroded surface expressions, which perhaps indicate the old course of the river. The tidal flats flank both sides of the river mouth.

Weathering and erosion which are dominant in this zone, discharge a considerable amount of sediments in the river and as a result prominent mud flats are being developed towards the lower reaches of the river. The river brings large amount of fine grained sediments which is confirmed from the aerial photographs by the presence of highly concentrated turbid water plumes discharging from the river. High concentration of suspended sediments in the nearshore waters of Ratnagiri is also reported from the study of Landsat images. From the nature and movement of this turbid water plume it seems that most of the suspended sediment load is being settled in the bay causing the heavy siltation. The offshore extension of the 15 m contour off Ratnagiri may be due to large accumulation of sediments brought by Kajvi river and smooth gradient of bay is mainly due to the river source. Loose sediments in the bay are about 20-25 m thick. Considering the
river length (66.5 km) and catchment area (540 km²) one can very well anticipate heavy rate of siltation in this bay.

Other important feature observed from the aerial photographs is the presence of a fast growing compound spit towards the southern side of the river mouth. For the waves from the south-west, the tendency of the sediment transport being mostly towards north the spit has diverted the river mouth for a considerable distance towards the north. The old beaches and dunes on them are now well stabilized by sand loving plants. The underwater extension of this spit towards north is very well seen from the aerial photographs. Low tide aerial photographs give a well marked picture of nearshore submerged features so that their underwater orientation and extension can be mapped easily. Echosounding data also indicate shallow areas towards the southern side of the bay due to major influx of sediments into this bay.

Towards the southern side of the bay (i.e. south of existing jetty) a well marked offshore sand bar is visible in aerial photographs. It can be traced for about 600 to 700 m trending NNW-SSE direction having a width of about 100 to 200 m. It occurs approximately 200 to 300 m away from the coast. Its upper part is visible during the low tide. The intervening portion between the offshore bar and the coast is being filled with the littoral sediments and ultimately the offshore bar will merge with the mainland caus-
ing the accretion of the coast. It can be observed that
the sand bar and the spit are almost blocking the
mouth of the river leaving a small opening that con-
nects the estuarine part of the river to the open sea.

From the general geomorphology of the bay and
its bordering coast it seems that in the bay the sea is
retreating causing the progradation of the coast
leaving behind paleociff and beach ridges. The
paleociff is no longer undergoing the wave attack
due to the retreat of the sea. The region between the
abandoned cliff and the present shore is occupied
by a well developed littoral terrace. It seems that pri-
or to the emergence of the coast the present Ratna-
giri hill was an island now connected with the main-
land by means of recent sandy deposits (tombolo).

Another important underwater feature observed
from the aerial photographs is the presence of a reef
like structure towards the northern half of the bay
(i.e. N-E of jetty). Its underwater extension can be
traced for about 750 x 750 m. Ground truth collec-
tion proved the existence of the rocky outcrop in
this region.

In the bay the dominant wave approach is from
WNW direction (January). These waves are subject-
ed to reflection and diffraction at the base of the
headland and refracted in the bay before reaching
the bay-head. Diffraction energy coupled with that
of refraction causes the southward longshore drift in
the bay leading to the accumulation of sand towards
the northern side of the jetty and in general creates a
low energy environment in the bay. In this region the
predominant wave directions is from S-W, W-S-W,
W and W-N-W, with periods ranging from 5 to 14
seconds. From the waves from W-N-W, the sediment
transport tendency is towards S.

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