CHAPTER 3: GEOLOGICAL FRAMEWORK

'Present is the Key to the Past'

-James Hutton

Geological framework of any region is assessed through its basic elements viz. lithostratigraphy, structure and tectonism. Geology plays a significant role in landform characterization, understanding the past and present processes and prospects of natural resources that include water resource, land and mineral wealth.

The candidate hereby would like to confess that being the student of environmental sciences; it is beyond the capacity of her to work out the geological details independently. Therefore author's endeavour to study the geological aspects of the Kim River basin is specifically aimed at understanding geology vis-à-vis the prevailing physical environmental processes, land use system and potential of land and water resources. Consequently, the candidate

has relied over the classic work available on the study area and adopted as such, with some field validation.

GEOLOGICAL SETUP

The Kim River Watershed area is characterized by a geological history ranging from 65 m.y. to present day. In spite of having tremendous mineral wealth, the study area is not widely studied in terms of its surface geology. Investigations carried out by the Oil and Natural Gas Corporation, Gujarat Mineral Development Corporation (GMDC) and the Gujarat Industries Power Co. Ltd. (GIPCL) for the purpose of oil, mineral and lignite explorations are the source of geological information of the study area.

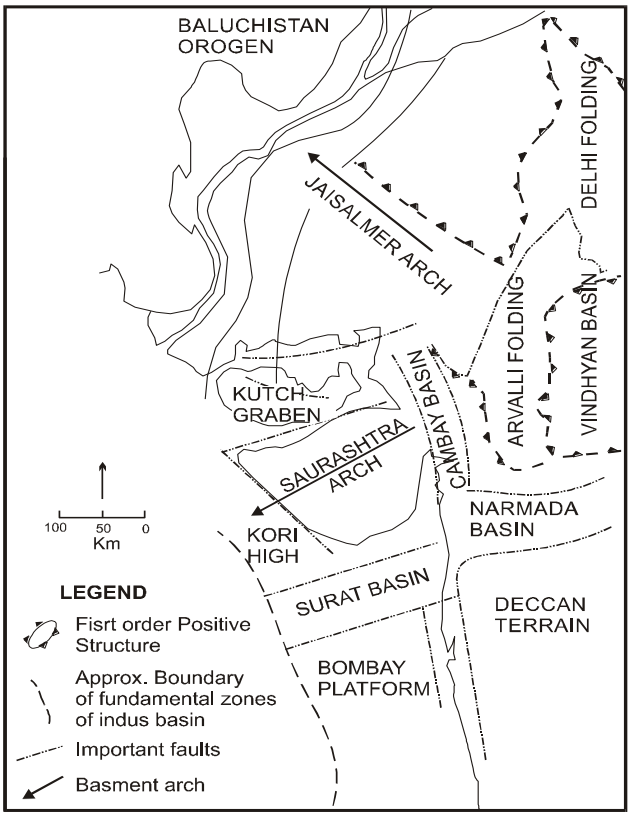

Figure 3. 1 Tectonic Trends of North Western India (Biswas, 1987)

The south Gujarat terrain is bounded by well-established framework of rift system. In south Gujarat, the Pericontinental Cambay and the Narmada-Tapi Rift systems have governed the sedimentation history of the Tertiary-Quaternary age. (Biswas, 1982, Kaila et. al. 1992).The Cambay rift basin (Fig. 3.1)

represents a narrow linear graben trending NNW-SSE and is situated between the Saurashtra Craton and the Aravalli Mountain Range. It remained as a rift valley with a number of volcanic eruption centres for Deccan traps, which are now seen as intra-basinal highs. The continual subsidence has led to accommodation of thick pile of sediments of the Tertiary and the Quaternary ages in the Cambay basin. (Biswas, 1987).

The Narmada-Tapi Rift basin (Fig. 3.1) is represented by the ENE - WSW trending system of faults (Biswas 1987, Das & Patel, 1984). The reactivation of the Narmada fault system has subsided the Cambay basin, making a way for deposition of mammoth thickness of the lower Tertiary sediments.

Lithostratigraphic Set-up:

Geologically, the south Gujarat terrain exhibit interesting litho-stratigraphic record ranging from Cretaceous to Recent time (Fig.3.2). Major information on geological aspects has come from the hydro-carbon exploration activities by the ONGC. The earliest account on the Palaeogene litho-stratigraphy of the area has been worked out by Rao (1969) based on the bore hole litho-logs drilled by ONGC. Chandra and Chowdhary (1969), through their extensive review of exposed and sub-surface sedimentary sequences have put-forth a comprehensive stratigraphic succession of the Cambay basin area. Gadekar (1975, 1980), through his studies has worked out a detailed stratigraphy of Jhagadia and Talodara area. Agrawal (1984) based on characterization of an individual lithology, their field relation, faunal and floral assemblage and mineralogical characteristics has proposed a revised stratigraphy. The candidate as a part of Kim River watershed study has adopted the same litho-stratigraphy (Table 3.1) as proposed by Agrawal (1984, 1987).

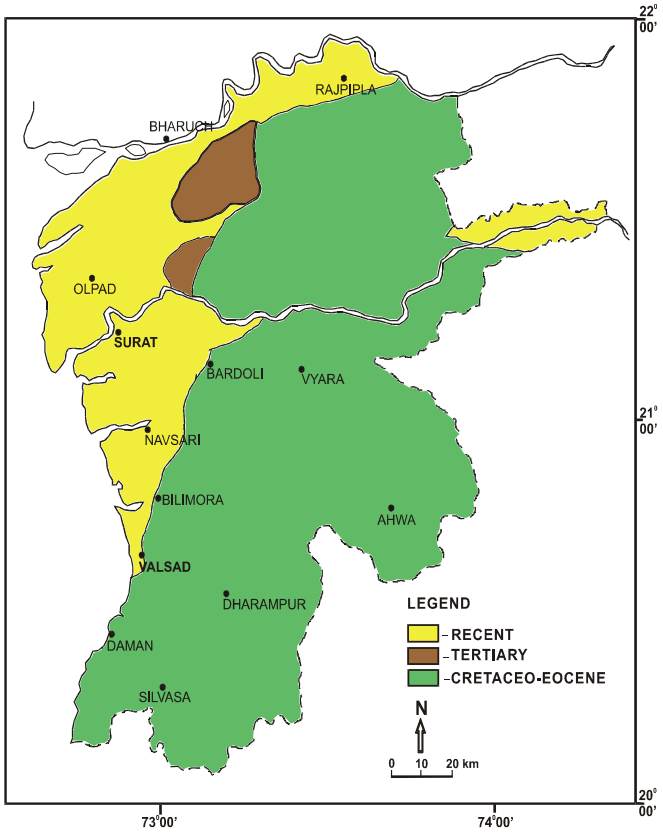

Figure 3. 2 Geological Map of South Gujarat (After, GSI, 1986)

A comprehensive litho-stratigraphy of the Kim River watershed and its environs as worked out by Agrawal (1984) is given as under-

Age	Litho-stratigraphy Unit	Sediment Characteristics
Recent To Sub-Recent	Gujarat Alluvium	Alluvium floodplain deposits, tidal flat muds, coastal aeolian sands etc.
Upper – Middle Miocene	Kand Fm.	Calcareous sandstone, limestone, clay and conglomerate
Lower Miocene	Babaguru Fm.	Ferruginous sandstone, agate conglomerates
Upper Eocene	Dinod Fm.	Fossiliferous limestone
Lower Eocene To Palaeocene	Vagadkhol Fm.	Black shale, sandstone, carbonaceous shale with coal
Upper Cretaceous	Deccan Traps	Extrusive Basalt lava flows

(After Agrawal, 1984)

Table 3.1 Litho-stratigraphy of the Kim River Watershed and Its Environs

The study area comprises three major geological formations, viz. the Deccan Trap that covers the eastern part of the study area, primarily composed of basaltic lava flows and the associated discordant magmatic bodies. Overlying the Deccan Traps are the younger sedimentary sequences of Tertiary and Quaternary age. Tracts of Quaternary coastal mud flats and alluvium plain are predominantly associated with the lower part of the river basin. (Fig. 3.3)

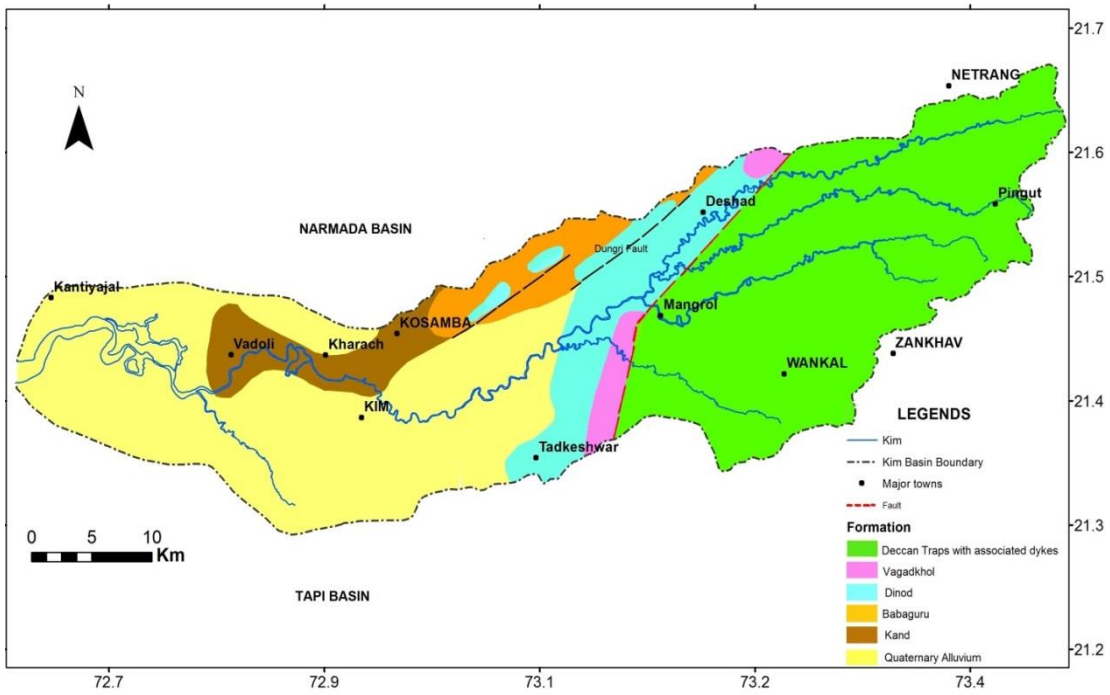

Figure 3. 3 Geological Setup of Kim River Basin (Modified after Agrawal, 1984 & CGWB,2013)

i) Deccan Traps:

The Deccan traps are the representative of the volcanic outbursts that occurred from Late Cretaceous to Early Eocene times that comprises the basaltic lava flows. The lava flows of the Deccan traps show occasional gentle dip towards the west along the western continental margin (West, 1959). Great variation is seen in the thickness of the Deccan Traps. The Tapi River region shows maximum sub-surface thickness of 1.8km (Kaila et. al. 1992).The Deccan Traps form the basement for the younger Tertiary and Quaternary sediments in the Cambay basin. In the study area, the trappean rocks occur in the eastern part of the basin as hillocks, narrow linear ridges and erosional pedi-plain. The

important rocks belonging to the Deccan traps are massive basalts, amygdaloidal basalts and associated andesite and trachyte. The basalts in the study area is extensively quarried as an important construction material (Plate 3.1).

Plate 3.1 A Close View of Basalt Quarry in the Kim River Basin (Loc. Pataldevi)

ii) Vagadkhol Formation:

Conglomerates and variegated clays are the main constituents. These rocks in the study area occur as narrow linear patch adjoining the Deccan Trap rocks. The conglomerates comprise clasts of basalt, claystones and agate, embedded within the ferruginous and calcareous matrix. The clays are of varied colours viz. red, yellow, reddish brown and at times mottled. The clays are associated with the sandstones units indicating fluvial- sub-aqueous environment (Agrawal 1984, 1987). Important locations of outcrop occurrence in the study area are all along the western margins of the Deccan Trap viz. north-east of Desad, Mangrol, Dungri and Nani-Naroli (Fig 3.3)

iii) Dinod Formation:

This litho-stratigraphic unit is characterized by its fossiliferous limestone. Outcrops of Dinod Formation occur as inlier bodies occupying gentle high grounds near Nandav, Dinod and Dungri villages (Plate 3.2). Further east, the exposers are seen continuing through Desad, Mangrol and further south of

Tadkeshwar. At places the outcrops are buried under the alluvium cover. The limestone outcrops display an antiformal structure and is of doubly plunging character. Based on the fossil assemblage, the rocks of Dinod Formation have been assigned Late Eocene age (Agrawal, 1984). These limestone outcrops are extensively quarried as a building material due to its compact nature.

Plate 3.2 A View of Outcrops of Fossiliferous Limestone (Loc. Dinod)

iv) Babaguru Formation:

Lithologically the Babaguru Formation begins with agate-conglomerate as basal unit, which in turn is overlained by ferugenized red sandstone unit. The strato-type section of the Babaguru Formation occurs near the Babaguru Dongri hill (Gadekar, 1976). The outcrops of this stratigraphic unit are amply seen along the northern-central boundary of the Kim watershed between Kosamba (SW) and Valia (NE). As this formation lacks any fossil content, its precise age is not known.

v) Kand Formation:

The Kand Formation is characterized by its diverse sediment content viz. calcareous sandstone clays, marls and thin bands of fossiliferous limestone of Early Miocene Age (Agrawal, 1984). The outcrops of Kand Formation can be

seen as patchy occurrence along the Kim Watershed boundary in the lower parts of the basin i.e. west of Kosamba town.

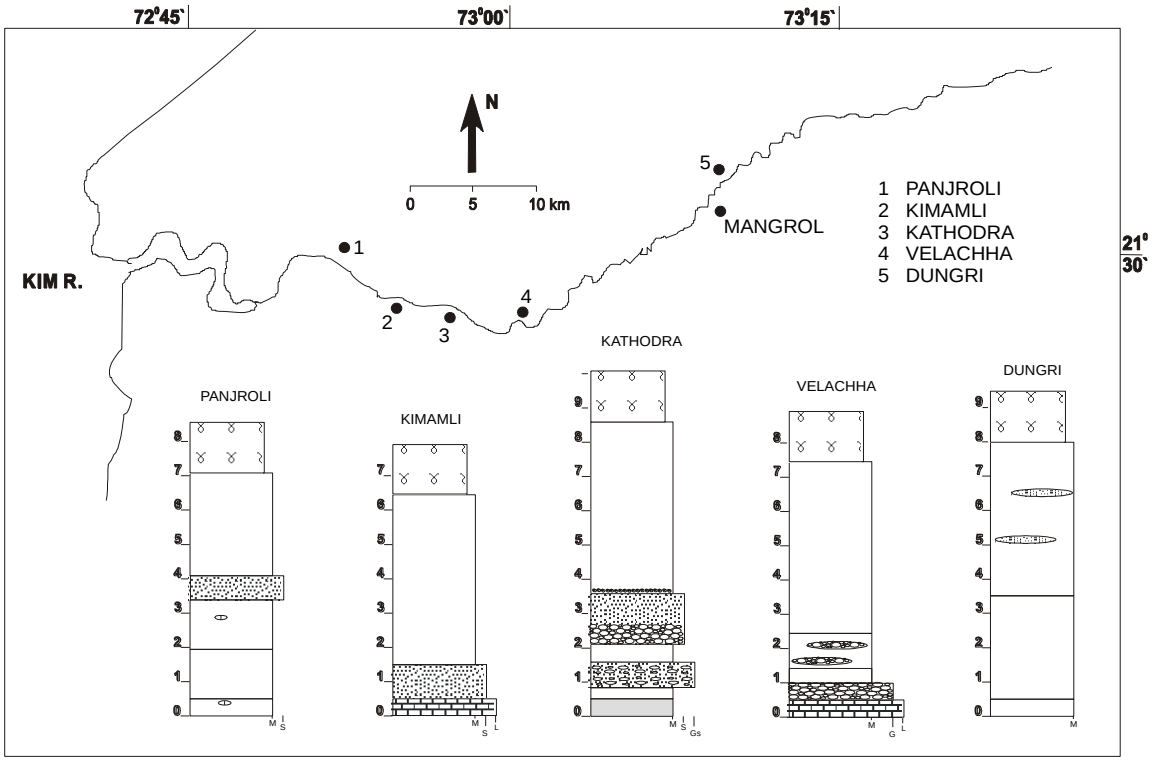

Figure 3. 4 Sediment Succession of Floodplain Deposits Exposed Along the Kim River Channel (After Tiwari & Joshi, 2001)

vi) Quaternary- Holocene Alluvium:

The Quaternary period in the western part of the Indian sub-continent was characterized by a combination of climatic and sea-level changes which is clearly reflected in the geological evolution of the Kim River Basin (Merh, 1992). The present day Kim River watershed is significant as it displays excellent disposition of Quaternary-Holocene sediments with an exposed Tertiary basement (Fig 3.4).

The Quaternary & Holocene sediments comprises as a mixture of unconsolidated sands, silts, gravels and clays residual of fluviatile and estuarine origin. Agrawal (1984) has designated these loose sediments as Narmada Formation. The Narmada Formation has been divided into three (03) members viz. (1) Residual soil, (2) Black Cotton soil and (3) Flood Plain Deposits. These

sediments have been mainly derived from the weathering of the underlying Tertiary sequences. These sediments occur either 'in-situ' or transported locally during floods. Although, the Kim River watershed region is also characterized by similar sediments; no attempt has been made to correlate with the suggested members.

Geological studies paly a very vital role in understanding numerous processes relevant to the physical environment of the study area. The geological information thus, described in the chapter has been further utilized in analysing the aspects of surface and groundwater hydrology.