CHAPTER - VIII

R E S U M E

The studies of the scattered exposures of Mesozoic sandstones in Gujarat are very interesting from point of view of their depositional history and their present disposition in relation to tectonics in various parts of Gujarat. Mesozoic sandstones in Gujarat are known as Nimar and Himatnagar sandstones in Mainland Gujarat, Dhrangadhra-Wadhwan sandstones in Saurashtra and Bhuj sandstones in Kutch. The Himatnagar sandstone formation comprises predominantly sandstones with minor layers of conglomerates, siltstones and shale or claystones. In the study area they rest unconformably over weathered Erinpura granites or Aravallis. The present study deals with the mode of occurrence, petrology, diagenesis, depositional environment and tectonic framework of Himatnagar sandstones.

Geomorphologically the area E,NE & SE of Himatnagar town is characterised predominantly by hilly terrain while the remaining low lying area has gentle southwestern slope comprising mostly alluvium with patchy exposures of sandstones. Three perennial rivers viz. Sabarmati, Hathmati and Meshwo flow through the heart of the study area and possess dendritic drainage pattern and `badland topography'. The quantitative analyses of drainage basin suggests the influence of lithology and lineaments in the drainage development of Himatnagar area.

The patchy exposures of Himatnagar sandstones occur in the major river beds, lowlying areas and on the top of elevated hill/ridges. The best river bed sandstone exposures of Hathmati, Sabarmati and Meshwo are seen near Himatnagar Kadoli and Mohanpur respectively. The low lying exposures are met throughout the study area; the prominent quarry exposures being near Panpur. The hill top exposures are encountered near Ghorwada, Berna, Gamdi, Wantra, Wamoj, Pedhmala, Adpodra and Bodi. The studies of the dug/bore wells have remained useful in confirming the sub surface extension of Himatnagar sandstones below the alluvium and also in understanding the tectonism.

The sandstones have variegated colour the most conspicuous being pink or brown. They are mostly angular to sub angular, coarse to fine grained, moderately compact. The sandstones are horizontally to sub horizontally bedded with gentle dips due west and exhibit more than one cycle of fining upward sequence

(cyclothems). They are characterised by inorganic sedimentary structures, primary as well as secondary. The primary structures include the planar as well as lenticular bedding, cross-stratification, graded bedding and scour and fill structures. The secondary structures incorporate the colour banding, ferruginous nodules and concretions. These structures indicate mostly their deposition in shallow water with westward paleocurrent direction under fluvial environments.

Petrographically the Himatnagar sandstones, on an average, are medium to coarse grained and occasionally fine grained, sub angular to angular, poor to moderate sorted with corroded boundaries and occasional authigenic overgrowth of quartz. The predominant cement is siliceous including cherty/chalcedonic and ferruginous, and occasionally argillaceous and rarely calcareous. The quartz grains show predominantly point (tangential) or line contact with floating grains and concave/convex to sutured contacts. The floating grains and point contact suggest the precipitation of cementing material during early stage of sedimentation probably at a shallow depth, while concave-convex to suture contact indicate cementation probably at a relatively deeper depth. Compositionwise these sandstones comprise more than 95% quartz, with rare and isolated grains of felspars (orthoclase, microcline, plagioclase, perthite), micas, hornblende, chlorite, apatite, epidote, augite, tourmaline, staurolite, zircon, topoz, olivine, sillimanite, rutile, sphene, opaques together with few rock fragments of pelites and psammites. These mineral constituents suggest their derivation

from igneous as well as metamorphic terrain. The angular to sub angular nature of quartz suggests less transportation and the nearness of source material. Though the granitic provenance is nearby, these sandstones are characterised by the impoverishment of felspar. The predominance of quartz suggests the mineralogical maturity.

The Himatnagar sandstones have been lithified predominantly by mineral precipitation (simple cementation). The early 'redoxomorphic' stage of diagenesis is characterised by (i) the presence of ferruginous cement and (ii) predominance of muscovite over biotite that suggests the dominance of oxidizing environments. The intermediate 'locomorphic' stage is recognised by the precipitation of primary cement like siliceous (silica, cherty to chalcedonic), argillaceous and calcareous cement. Modification of opal to cherty/chalcedony and replacement of cherty cement by the calcareous cement as also the authigenic overgrowth on quartz is typical of locomorphic stage. The late phyllomorphic stage of diagenesis is marked by the development of authigenic micas as also the co-existence of muscovite and chlorite in the sandstones suggest slightly more oxidizing environments. The siliceous cement could be due to silica super saturated pore waters or deep weathering of felspar and silicates by meteoric waters. The ferruginous cement originated from the ferro-magnesian minerals present in the provenance rocks.

The depositional environment of Himatnagar sandstones is ascertained from colour, variation in grain size, sedimentary structures, mineral maturity, organic matter etc. The pink or brown colour might have formed due to oxidation of ferric iron and/or insitu alteration of fresh ferro-magnesian silicates in hot dry region. The source material for red pigment could be derived from Erinpura granites, basic intrusives and metamorphic rocks under tropical to humid tropical climate. The fining upward sequences in some of the exposures with lower conglomeratic gravelly bed corresponding to channel lag deposits. The medium grained sandstones indicate their deposition in channel/point bar deposits of fluvial regime. The top clayey layers point to flood plain deposits. The cross-stratification suggests the deposition at shallow turbulent at or above the profile of equilibrium. The paleocurrent direction due west indicates the deposition by westerly flowing river systems. Graded bedding gives clue on the deposition in relatively deep water below wave zone. The co-existence of cross stratification and graded bedding in some of the sandstones suggests the possibility of fluctuation in the depositional basin during the sedimentation of Himatnagar sandstones. The particles size analyses also indicate that the Himatnagar sandstones have been deposited in channel/point bar under dominant influence of fluvial environments.

The paucity of felspar in sandstone could be due to deep weathering of granites prior to the on set or contemporaneous

with sedimentation and the deposition over a long span of time in a low relief & tropical climate in mildly unstable platform or cratonic basin. The presence of kaolinite in sandstone as also the presence of plant fossils support the deposition by fluvial agencies.

In northwestern India the major lineaments (rifts and horsts) are styled by a conguagate system of three principal Pre-Cambrian orogenic trends viz. (1) Dharwar (NNW-SSE) (ii) Delhi-Aravalli (NE-SW) (iii) Satpura (ENE-WSW) and their subsequent reactivations in Mesozoic and Cenozoic Eras has given rise to the birth of the Kutch, Saurashtra, Cambay and Narmada basins. The Himatnagar area has been affected by the tectonic activities. The disposition of sandstone exposures at various altitudes could be explained by step faulting. This is evidenced by the presence of fault breccia, slickensides etc. in the sandstones. The faulted contact near Mohanpur between trap and sandstone also support this contention. The structure contour and isopach maps prepared from dug/bore well data have helped in understanding the present configuration, overall thickness and depositional trends of Himatnagar sandstones. The structure contour maps on Erinpura granites, Himatnagar sandstones and Deccan trap clearly indicate the faulting along basement grains viz. Dharwar (NNW-SSE) Aravalli-Delhi (NE-SW) and Satpura (ENE-WSW), of which the Dharwar trend is predominant. The isopach map of Deccan trap suggests the faulting along Dharwar trend after initiation of volcanic activity. The isopach map of Himatnagar sandstones suggests that the deposition might have taken place atleast by

two separate river systems. viz. Hathmati and Meshwo river. This is inferred from the presence of two separate lobes of maximum deposition of sandstones by westerly flowing river systems from the igneous and metamorphic provenance.

The geological sections drawn across the study area clearly suggests southwestward to westward step faulting; the faulting having taken place after the eruption of Deccan trap that has affected the rocks down to the basement. This faulting (Dharwar trend) is across the main deposition trend (EW) of sandstones. These sandstones extend at a deeper levels to the west or southwest of the study area. In the northern part of Cambay basin sandstones below Deccan trap were deposited in continental environment; the provenance being Erinpura granites and Aravallis-Delhis. In Saurashtra the Dhrangadhra sandstones of Lower-Cretaceous age with westerly paleocurrent direction were deposited under fluvial to detaic environment; the source rock being igneous and metamorphic rocks from east.

The sandstones of Himatnagar area are lithologically closely analogous to those of Cambay basin and Saurashtra peninsula area. They are rich in quartz with impoverishment of felspar, and common provenance-all when considered in the regional tectonic framework of northwestern India suggests their deposition on a common platform in Early Cretaceous period. During late cretaceous period in northwestern Peninsular India concomittant with volcanic eruption, the tensional faults parallel to the

ancient basement grain (predominantly along Dharwar trend) have resulted into the formation of rifts or grabens with numerous step faults giving rise to present disposition of Himatnagar sandstones.

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