CHAPTER I

INTRODUCTION

Vast spread of the 'Deccan Traps', covering an area of over 500,000 square kilometres in the western and central parts of India, is constituted mostly of tholeiitic basalts, although some picritic basalts and those with alkali olivine parentage are noticed at places. The monotony of the basalts is however broken near the western fringes of the 'Deccan Traps' where some acidic and alkaline rocks are noticed near Bombay in Maharashtra, and in parts of the Gujarat state at and around Amba Dongar, Netrang and Pavagad. These rock types have received attention of many workers in the past and detailed petrographic and petrochemical accounts providing genetic significance of many of the acidic and alkaline variants, belonging to this volcanic province are available.

The area around Bombay, in particular, has been the focus of attention of various geoscientists, ever since the middle of the last century. Clark in 1869, and Glennie in 1932, suggested that this area could be the focus of volcanic eruptions. Professor Sukheswala and his colleagues, from St. Xavier's College Bombay, have made significant contributions to the geology of the Bombay area, through their uninterrupted wor
for more than last thirty years. It was however observed that the detailed mapping with regard to the structural aspects, was lacking, especially in the area north and east of Bombay except for the few observations of some workers (including Carter 1850, Blanford 1867 and Clark 1869) regarding the higher dips of the basalt lavas in the area and Auden's (1949) well known observation of the monoclinal flexure in the Kalyan-Panval region. In view of this, about 2000 sq. kilometres area around Bassein and Bhiwandi was selected for a detailed study with the main objective of delineating the structural configuration in relation to the various lithologic types. These studies have led to the recognition of the Bombay-Bassein area as a 'Cauldron Subsidence' area to provide a finite dimension and concrete support to the views of Clark, and Glennie (op. cit.).

Area of Investigation

The area covering approximately 2000 sq. km bounded by latitudes 19°15' to 19°40' N and longitude 72°30' to 73°15' E and included in the Survey of India toposheet Nos. 47A/11-15, 47A/14, 47A/10 and 47A/3, forming parts of the Thane district, Maharashtra (Fig. 1.1), was selected for the present investigations. Bombay-Agra National Highway No. 3 and Bombay-Ahmedabad Western Express Highway No. 8, form the major communication channels in the area. Hot springs with their temperature ranging between 38° to 58°C are located in
Fig. 1-1 INDEX MAP OF THE AREA

(Figures represent toposheet No.)
Ganeshpuri - Akloli area, near Sativali, and Koknere. Bhiwandi, an important industrial township about 60 km northeast of Bombay, is situated on the Bombay-Agra National Highway. The Western Railway, passing through the coastal part links the important townships of Bassein and Virar with Bombay. Bassein-Diva railway line passing through the southern part of the area, is expected to commence its operation in near future. This will provide another rail link in the area. It is already open for goods traffic and will be extended to link Panvel and Vashi town soon. Besides, all important places are connected with the highways by means of jeepable, tarred and metalled roads. Foot-tracks and cart-tracks are important arteries of communication in the densely forested areas of Tungar-Kamandurg and Kuradla hill ranges. The important places are shown in the location map of the area (Fig. 1.2).

Topography and Drainage

The narrow coastal strip in the western part of the area is a flat and lowlying country, covered mostly with alluvium and mud flats. The coast line is characterised by many creeks encroaching the main land. Eastern part of the area exhibits a hilly and rugged topography, the hills rising as much as 655 metres (Tungar Peak). Other peaks are Kamandurg (606 m), Takmak (600 m) and Ghotara Dongar (560 m). Hill ranges west of Khadki Khurd, and Parol-Saphala region lie in an arcuate pattern.
Fig. 1.2: Location map of the Bhiwandi-Bassein area
Their north-south trend in the southernmost part of the area under study becomes NW-SE when followed northwards. Beyond the study area southwards, the hill's trend in a NE-SW direction, thus exhibiting a semicircular pattern, from Bombay to Mahim. In the other parts of the area under study, the hill ranges, in general strike North-South.

River Ulhas and river Vaitarna along with their tributaries form the main drainage system in the area. River Tansa is the main tributary to the Vaitarna river. River Kalu forms main tributary of Ulhas river. These rivers flow in a general westerly direction, their courses being locally modified by structural features such as faults, dykes, and major fracture systems. The drainage shows barbed pattern indicating strong structural control. The landforms exhibited in this flat coastal flats are covered with beach sand and mud deposits. Broad flat hinterland areas along the major rivers are covered with alluvium.

Previous Work

The credit of introducing the term 'Deccan Traps' goes to W.H. Sykes (1833), who first used it to describe the steplike topography formed by almost horizontal lava flows of the Deccan area. As stated earlier the Deccan Traps of Bombay and the surrounding region received considerable attention of the
geologist since the middle of the 19th Century. Carter (1850) and subsequently Wynne (1866) gave detailed account of the geology of Bombay. Occurrence of the raised sea beach, about four metres above high water mark led Buist (1851) to conclude that the part of the area has undergone elevation. Ormiston, resident engineer of Bombay Port Trust, discovered clear evidence of subsidence of the island. This led Blanford (1877) to conclude that the area has alternately undergone uplift and subsidence. Clark (1869, 1880) who recognised the tilting of the flows in Bombay area observed that the hills of the Salsette were sharp topped and steep, while mountains of Konkan are flat topped and horizontal. He felt that the origin of the traps must be sought either in the area of Bombay or in the adjacent margin of Konkan. Blanford (1867), while giving detailed account of the 'Deccan Traps' recorded that the observed dips in Bombay area were due to the subsequent disturbances. While describing the dykes in the north Konkan area, Auden (1949), recognised a monoclinal flexure, the axis of which runs through Kalyan and Panvel in a north south direction. Auden considered that these intrusions are of Post Deccan Traps age. Another post trappean structural disturbance has also been recorded by Auden (1954) in the form of north westerly trending shears occurring near Tansa reservoir.

Detailed petrographic account of the rocks of the Bombay area has been given for the first time by Sukheswala (1954-55),
who mentioned that the presence of cones or conelets along a north-south lineament indicates the existence of a weak zone in the Bombay area. Sukheswala and Poldervaart (1958) discussed the geochemistry of the rocks of the Bombay region and concluded that the acidic rocks are the products of differentiation of the basic magma. Sukheswala and Sethna (1962) described geology of the Bassein area and opined that the acidic magma resulted from the partial melting of the lithosphere. Sukheswala (1974) discussed the origin of the spilites of Bombay and attributed it to the deposition of lava in sea water, while Valance (1974) observed that the local hydrothermal and regional burial metamorphism offer a better proposition for the origin of spilites. Petrogenesis of the trachytic rocks is discussed by Sethna and Battiwala (1976) suggesting that the trachytes and the basalts of Sakinaka quarry have erupted simultaneously. Possibility of intermingling of two magma types has been discussed by Sukheswala and Sethna (1978). Recently, Sukheswala (1980), has suggested that the different rock types could have independent sources.

Observations by these workers were restricted to the island of Bombay, and the nearby area. Geological Survey of India launched an intensive programme of systematic geological mapping of the 'Deccan Traps' after the Koyna earthquake of December 1967. Under this programme, Muthuraman and Murthy (1974-75) carried out geological mapping north of Panvel.
Although they had noticed few faults in the area, they did not find any evidence for the presence of a flexure. Muthuraman, Godbole and Joshi (1975-76); Godbole and Joshi (1976-77) and Godbole (1978-79), however, reported field evidence in favour of the continuation of the Panvel flexure in the Bhivandi area and further north. Ghodke (1978) carried out detailed petrological and structural studies in the area around Panvel and substantiated the presence of a monoclinal flexure in the area. Raman (1979) carried out more work in the Bombay area and gave a detailed lithostratigraphy. Godbole (1981-82) mapped parts of the area covered by toposheet No. 47A/11+15 and reported presence of an arcuate fault separating pahoehoe flows from the volcanic-plutonic complex.

Glennie (1932), was the first to carry out geophysical work in this area. He considered the high positive gravity anomaly near Bombay as due to the massive intrusion of basic rocks. Takin (1965) extended gravity observations from land over to continental shelf, which indicated a high positive gravity closure. It was explained as due to the intrusion of high density material in the lithosphere or as a result of generation of secondary magma chamber. Kailasan (1972), observed that the Panvel flexure is well brought out by the gravity values and is associated with a deep seated fault system. Auden (1975), while examining the gravity data opined that the high density
material along the west coast from Bombay to Surat probably does not represent intrusion of the high density mantle material. Bose (1981), opined that the high positive gravity values from Bombay to Surat could represent a dragged mantle plume.

Method of Investigation

In order to achieve the goal of working out the genesis of rock types in relation to their structural history and tectonic setting, field and laboratory studies were undertaken, partly as an official assignment in the Geological Survey of India, Maharashtra Circle (West), having the Circle Headquarters at Pune, and in the Department of Geology, University of Poona.

Field Investigations: Systematic geological mapping of the area covering approximately 2000 square kilometres around Bassein and Bhiwandi was carried out on 1:63360 scale using Survey of India toposheets. Large scale map using Brunton compass and Tape, was prepared covering an area of about 4 sq.km near Sativali on 1:5000 scale. Structural elements like gradient of the basalt flows, regional joints and fractures, were recorded during the geological mapping. Dykes, sills and other intrusives were also plotted on the map following usual practices. Faults and shears were traced along their strike and were marked on the map. Representative samples, of different rock types were collected for laboratory studies.
Laboratory Investigations: Laboratory studies including petrography, chemical analyses, aerial photo and satellite imagery interpretations etc. as supplementary to the field observations and geological synthesis of the entire data was undertaken largely using the facilities at the Department of Geology, University of Poona, as well as the Geological Survey of India. Electron Micro Probe Analysis (EMPA) of selected samples became possible at the Department of Earth Sciences, University of Cambridge and the Department of Geology, the University of Hull, U.K. through the courtesy of Prof. J.V.P. Long and Prof. A.C. Dunham respectively.

A. Fracture Trace: Maps of the area were prepared with the help of aerial photographs which were available on 1:40000 scale with approximately 60% overlap and also using Landsat imageries. The photographs were studied under Carl-Zeiss stereoscope fitted with monoculars. Besides this, other structural details like faults, dykes, and directions of dips were also recorded. This exercise was followed by field checks.

B. After completion of the field work, various geological maps and cross sections were prepared.

C. Petrographic study included the study of megascopic characters and mineralogical and textural study of the representative rock samples.
D. Chemical analysis for the major oxides was carried out by using classical method in the G.S.I. (Geological Survey of India) in which the powdered rock sample is fused with sodium carbonate. Silica which remains as residue is determined gravimetrically by using HF. Insolubles are fused with potassium pyrosulphate and are extracted with HCl and added to the main solution, from which $\text{R}_2\text{O}_3$ was determined gravimetrically. CaO, MgO and Fe$_2$O$_3$ are determined volumetrically and TiO$_2$ and MnO by colorimetry. P$_2$O$_5$ was also determined volumetrically. Na$_2$O and K$_2$O were determined by flame photometry. FeO was volumetrically determined from separations of the sample powder in reducing medium.

Electron Micro Probe Analysis of few selected samples was carried out at Cambridge and Hull using Energy Dispersive System (EDS) developed by the Department of Earth Sciences, Cambridge. In both the cases 80 live seconds counting time was given under 20 KV as the accelerating voltage and 50 nA as the specimen current. The samples were prepared into normal size polished thin sections and were coated under vacuum for 15 seconds with carbon before subjecting to EMPA. Natural gem quality Olivine from St. John's islands and pure Cobalt were used as standards treated similarly as the samples.