CHAPTER III

GEOLOGY OF FIRECLAY AND ASSOCIATED ROCKS OF SAURASHTRA

Previous Work

Fedden (1884) was the first to carry out the geological mapping of this region. He correlated the plant bearing beds exposed around Than with the Umia beds of Kutch. Oldham (1893) described the Mesozoic sediments of Saurashtra as 'Kathiawar beds' in his manual of Geology of India. Fox (1931) correlated the 'Kathiawar beds' with the Upper Gondwana rocks and discussed the problem of their age and correlation. Dunn (1942) reported occurrence of coal and coaly shales in a number of borings made at Morvi, Wankaner, Dhrangadhra, Satapur, Halvad, Khakhrathal, Wadhwan, and in well sections at Tarnetar and Ranipat, and observed that coal is of poor quality and seams are too thin to be mined economically. B.C. Roy and Karunakaran (1953) investigated the known fireclay deposits in Madhya Saurashtra and described their occurrence. Roy (1953) described ground water conditions, geology, occurrence of fireclay, its beneficiation and industrial applications in Saurashtra in his book on

"Economic Resources of Saurashtra". Pascoe (1956) described 'Than beds' in his manual of Geology of India and Burma Volume II. Krishnan (1956) regarded the lower half of the Dhrangadhra Formation as equivalent to the Jabalpur beds and the upper half to the Umia beds. He has also correlated Dhrangadhra sandstone with Himmatnagar sandstone Formation which is Lower Cretaceous (Wealden) in age. Arkell (1956) correlated plant beds of Saurashtra with Umia plant beds (Bhuj series), which are Middle Cretaceous (Albian) in age. Poddar (1959) gave Upper Gondwana age for the 'Kathiawar beds' covering an epoch of time from Middle Jurassic to possibly, Upper Neocomian. Shrivastava and Rizvi (1960) proposed the name Dhrangadhra Formation for these beds, and studied sedimentological aspects. Rao (1961) estimated the thickness of the exposed section to be about 500 meters and carried out gravity and magnetic surveys in Morvi - Maliya - Halvad area and expected a large thickness of sediments to be present below the exposed thickness. Rao et al (1962) regarding the high dips in the Dhrangadhra Formation at some places in the northern part of its exposure, suggested as to be probably caused by a concelaed fault beneath the alluvium. Varma and Rawal (1962) identified a rich assemblage of microflora from Dhrangadhra. Morvi, Chotila and

Surendranagar areas from the collection made by P.V. Rao. The area has been mapped in detail by various geologists of Oil and Natural Gas Commission and the geological data has been compiled by Shrivastava (1963). Fireclay from this formation has been studied quantitatively to evaluate plastic clays regarding their suitability as substitute for ball clays by Gosh et al (1962). Bishui and Prasad studied physico-chemical properties of fireclay using D.T.A., X-ray diffraction, and chemical analysis to calculate mineral make up by norm method and to assess its quality. Bhandari and Kumar (1970) carried out palaeocurrent analysis of Dhrangadhra Formation and gave the following conclusions:

1. The paleocurrent directions in the study area indicate westerly current directions during the deposition of Dhrangadhra Formation.

2. The sediments comprising Dhrangadhra Formation were derived from the Archaean, Aravalli and Delhi rocks exposed across the Cambay Basin to the east of the study area.

3. The Dhrangadhra sediments were deposited in a fluvial to deltaic environment.

4. The pre-Trappean Mesozoic hydrocarbon products in the Cambay Basin, particularly in the northern part appear doubtful, as the paleo-geographic reconstructions suggest absence of Mesozoic graben between the Aravalli and Dhrangadhra outcrops.

Nautiyal (1970) mentioned localities of fireclay occurrence while describing the mineral resources of Rajasthan and Gujarat. Sheth (1970) gave data on the production of fireclay and its manufacturing units in Gujarat. Dikshit (1970) while describing the climate, rainfall, soil, vegetation and physiography of Gujarat; has also given geology and mineral resources of Dhrangadhra Formation. Kathiara (1970) studied some measured sections and bore holes of the Dhrangadhra Formation while carrying out investigations for coal in Khakhrathal area. During this work, he described certain sedimentary structures and concluded that these rocks were deposited in the lower river regime and in the active deltaic region of a south-westerly flowing river system. Kathiara and Bhatt (1971) while studying sedimentology of the Dhrangadhra Formation, Khakhrathal area, Surendranagar district, described geology, age, sedimentary structures,

depositional environments, texture, mineralogy and grainsize analysis of sandstone. Kathiara et al (1971) divided exposed Dhrangadhra Formation into three stages viz. Suraj Deval, Ranipat and Than on the basis of lithological variations. Ghosh et al (1971) of Central Glass and Ceramic Research Institute described district-wise localities and occurrences of fireclay deposits of Gujarat. Bhatti and Chavada (1977) studied the physico-chemical properties of fireclays from Muli, Sadla, and Ranipat with respect to appearance in raw character, green properties chemical analysis, fired properties at different temperatures, and pyrometric cone equivalents and concluded that Muli and Sadla fireclays can be used for sanitarywares, stone-wares etc, while Ranipat fire-clays is suitable for white-ware industry. Chavada et al (1977) collected fireclay samples from Makansar, Sultanpur and Matel during their field session, studied properties, appearance in raw character, green properties, chemical analysis and fired properties at different temperatures and described their usability. Talati and Desai (1977) while describing the problems and techniques for the exploration of refractory clay deposits of Upper Gondwana sequence, Saurashtra, discussed geology and

guide-lines for their exploration. Chavada et al (1977) studied physico-chemical properties of Vinaygadh and Songadh fireclays. Malkan et al (1977) while describing the availability of raw materials for glass, ceramic and refractory industries in Gujarat, have given the physico-chemical properties of fireclays from Khakhrathal and Morvi.

Dhrangadhra Formation

The exposed part of the Dhrangadhra Formation, comprises of approximately 94 percent sandstones, 5% shales and 1% clays. Small stringers of coal occur occasionally. Coal is not economically exploitable because of its small thickness and poor quality.

Sandstones comprise of felspathic sandstones, fine grained argillaceous sandstones, quartzites, ferruginous sandstones etc. Most of the sandstones are coarse and gritty, occasionally medium to fine grained, cross bedded and unevenly stratified. They are mostly white in color, but sandstones of yellow, pink, purple and brown shades are also common. The coarse sandstone often grades into conglomerate. Small, irregular bands of conglomerate is seen at number of places. Pebbles

varying in length from 1 to 3 cms along their maximum dimension are common in sandstone. These pebbles are irregularly seggregated, angular and semi-rounded. Sandstone shows poor sorting of grains. Numerous gritty layers are common. The sandstone is sometimes poorly cemented and friable. As a result of silicification, hard, quartzitic sandstone is formed. The cementing material usually grey or mottled clay is often siliceous, calcareous or ferruginous. Highly ferruginous, coarse grained, brown sandstone referred to as an ironstone band by Fedden (1884) occur near Surajdeval temple.

The Dhrangadhra Formation consists of numerous lenses of white, grey and purple colored sandstones and 0.3 to 1 m thick carbonaceous shales. Occasionally thicker shale zones having sandy intercalations are observed.

Occurrence of coal is reported in a number of borings made at Morvi, Wankaner, Dhrangadhra, Wadhwan, and Khakhrathal. At Tham, Tarnetar and Khakhrathal coal is observed under the thick pile of sandstones in fire-clay mines. Coal is of poor quality and seams are too thin to be mined economically.

Fireclays, as bedded sedimentary rocks are common in the Gondwana Formations. At Than, Tarnetar and Khakhrathal fireclays occur below thin stringers of coal. Color of the fireclay varies from white, grey to black. Fireclays are extensively mined from intercalations in Dhrangadhra Formation at Sadla, Palasa, Songadh, Tarnetar, Makansar, Jambudia, Matel, Vinaygadh, Ratidevali, etc. Usually, fireclay occurs as pockets in Dhrangadhra sandstone. At some places, e.g., at Than, it contains numerous plant fossils.

The base of Dhrangadhra Formation is not exposed. Plant fossils identified by previous workers show affinity towards Jabalpur beds of the Satpura region and the Umia beds of Kutch. Dhrangadhra Formation represents an epoch of time from upper most Jurassic (Tithonian) to Lower Cretaceous (Neocomian) and probably upto Middle Cretaceous (Albian). It is overlain by Wadhwan Formation.

The presence of bright colors such as purple, red, yellow and brown in the sandstones and clays points to a continental environment of deposition. The abundant current bedding, uneven stratification and poor sorting of sandstones, suggest rapid accumulation of the clastic sediments. Large scale current beddings occur

frequently. Presence of coal and plant remains indicate that these sediments were laid down in areas of subsidence. Presence of a few marine micro-fauna in the upper part of this formation probably indicates the transitional (Deltaic) environment of deposition for at least the upper part of this formation.

Dhrangadhra Formation, in the northern part of its exposure, shows high dips, perhaps due to unseated fault covered by alluvium. The gravity and magnetic surveys carried out in the alluvial areas north-east of Dhrangadhra by previous workers have given indications of an east-west fault parallel to the north coast of Saurashtra. Dhrangadhra sandstone being uniform in character, it becomes difficult to detect any fault in it. Considerable fracturing and disturbance in the strata are present in a number of places which are intruded by dykes. It appears that faulting is associated with some intrusions.

A fault scrap with slickensides has been noticed in Dhrangadhra Formation to the south-west of Chuli village, by previous workers. The fault strikes in a north-west-south-easterly direction, with down throw side towards south.

Near Khambbra village, a north-north-east, south-south-west fault has given rise to a fault scarp and high dips (24° to 30°) of the generally low dipping beds of Dhrangadhra Formation. The nature of the drag indicates that the down throw side is towards west.

In Dhrangadhra Formation the beds are gently dipping in all directions and away from a central area around Tarnetar. This indicates the possibility of a broad regional dome, which is cut off on the eastern side by the faults of Cambay graben under the cover of the alluvium. It is not possible from surface studies to determine the exact nature of the dome because of the absence of marker beds, scarcity of exposures and poor reliability of dips. In the north-eastern Saurashtra the rocks of this formation show folding to a small extent.