CHAPTER - I

CHAPTER-1

INTRODUCTION

General

Bentonite designating a distinct type of clay is a young name in mineral nomenclature in the light of the age old names of most other useful non-metallics. The earliest references in literature are to "soap clay" (1873), "taylorite" (1888) and finally bentonite; a term applied by Knight (1897) to a particular highly colloidal, plastic clay found in the Fort Benton series of rocks near Roch Creek, Albany County, Wyoming (Joshep, 1980).

The dominant clay-mineral component of bentonite is montmorillonite. Illite and Kaolinite are also present in many bentonites.

Bentonite is a commercial term for a "fine grained clay containing not less than 85% montmorillonite" (Ross and Hendrick, 1945).

The world's chief supply of bentonite is obtained from the United States. It is found in nearly every state west of the Mississipi River, and also in a belt extending from Kentucky to the Gulf. About one-half of the output comes from the Wyoming-South Dakota area. Another producer is Panther Creek, Mississipi. Western Canada has numerous deposits of bentonite, the chief being in Southern Mamtoba.

One of the largest known deposits of bentonite outside the United States, is that occurring on the Isle of Ponza in Italy. Bentonite is also being produced in Australia, New Zealand, Japan and the U.S.S.R.

In India, Bihar, Gujarat, Jammu and Kashmir and Rajasthan are the important states where commercial deposits of bentonite are found.

Gujarat state has established itself as the largest produoer of bentonite in India. In Gujarat, Kutch, Bhavnagar, Amreli, Broach, Jamnagar, Banaskantha, Sabarkantha and Kaira districts are the potential areas producing bentonites.

Study area

The study area forms the south-eastern corner of the Saurashtra peninsula of Gujarat state (Fig 1). The coastal segment of Saurashtra is well known for its huge mineral deposits formed due

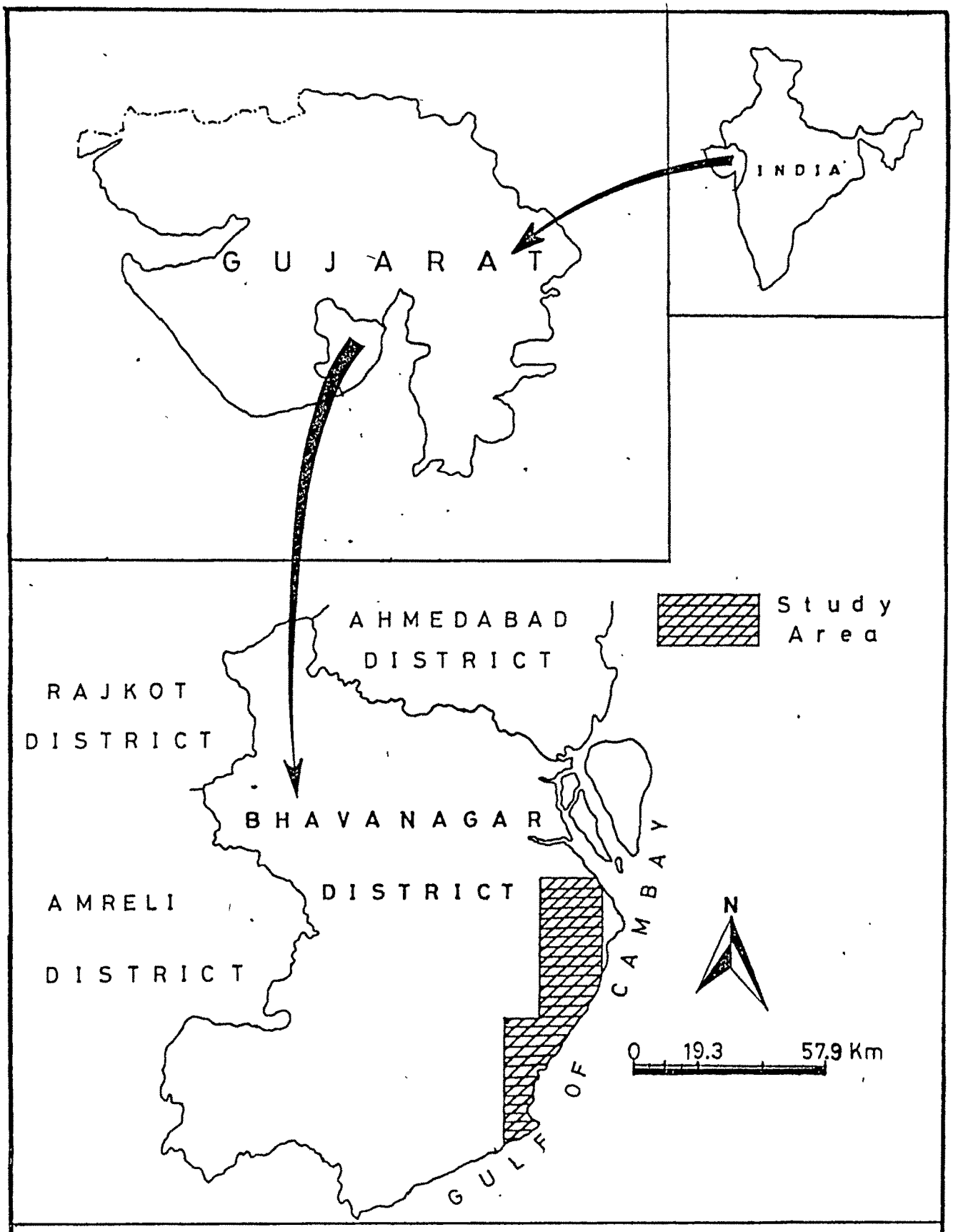

FIG.1: LOCATION MAP

to the weathering/lateritization processes. In the present study area of the Bhavnagar district Eocene laterite has developed over the Cretaceo-Eocene Deccan Trap lava flows. The common occurrence is in the form of a narrow, elongate, nearly N-S belt. The unique feature here is the occurrence of large, economic deposits of bentonite associated with the lower parts of the lateritic weathering profile.

With extensive oil well drilling in Gujarat and elsewhere the demand for bentonite has been increasing over the years, because bentonite is used as a drilling fluid during the drilling operations. Other applications of bentonite is in the decolorising of oils, as alsifilms, in pharmaceuticals, in cosmetic industries etc..

Location

The study area in Bhavnagar district has been restricted to the occurrence of bentonite and lies between 21°15′ and 21°45′ north latitudes and 72°0′ and 72°15′ east longitudes and forms a part of the Survey of India Toposheet numbers 46 C/2, 46 C/3 and 46 C/7.

The most important bentonite pockets in the study area are located in and around Budhel, Adhevada, Tagadi, Thoradi, Rajpara, Padwa, Morchand, Thalsar, Tansa, Alang, Mathwada, Devaliya and Sakhavadar villages.

Geography

The study area is bounded by Surendranagar and Ahmedabad districts in the north, Rajkot and Amreli districts in the west, Arabian sea and part of Amreli district in the south and the Gulf of Cambay in the east.

Physiography and Drainage

Most of the Kathiawar hill ranges run north-east and south-west forming irregular chains crossing the peninsula in nearly parallel lines.

The north-eastern series begins a little to the east of Kotda-Pitha and stretches northward throwing off two branches, one known as the Mandar hills, which goes north to Chotila and Than and finally sinks into a plain at Dhrangadhra. The other one known as the Thanga chain begins as a stony plateau with low barren ridges and gradually develops into a succession of short rocky ranges culminating in the Barda hills overlooking the Arabian sea at Porbandar.

The district of Bhavnagar has very few hill ranges belonging to the northern system except its outliers which passing through the Kothda-Pitha and Kotda Sangai in Rajkot district, almost form a central highland region and abut into the district making its north-western part, namely, portions of Botad and Gadhada divisions hilly.

The south-western system of Kathiawar hills penetrate into the district making Kundla, Palitana and Sihor quite hilly. Generally

the height of these hills ranges from 335 to 500 m. Beyond the Shetrunji, the Mordhar range appears in detached masses known as Shetrunjaya and Lonchi hills rising abruptly to 500 m. and 667 m. respectively.

Apart from these two hill systems of Kathiawar which dominate the north-west and central-south of Bhavnagar district, the two other distinct physical regions of the district are the coastal plain and the inland plain. The coastal plain of Bhavnagar has been divided into three sections. First one from Sonrai Creek to Gogha, the seoond from Gogha to Gopnath point and the third from Gopnath to Gadhada.

The inland plain lies behind the coastal belt which in the southern part of the district holds enough fresh water and is of great fertility.

In Bhavnagar district the rivers head directly to the Gulf of Cambay in the east or they carry the drainage from the lesser Gir, to the south into the Arabian sea. Many of the east flowing streams also recieve tributaries from the lesser Gir, Lonch and Mordhar hills. These tributaries then flow north or north-east to meet the east flowing rivers. From the counter slopes of the opposite chain of hills flow the largest of the rivers of Kathiawar, viz., the Bhadar and the Shetrunji. Rising at almost opposite points, they meet the drainage in the centre of the peninsula and flow through the plains, the Bhadar towards the

Arabian sea and the Shetrunji eastwards through the Bhavnagar district into the Gulf of Cambay.

The main rivers and streams flowing through the area are the Shetrunji, Ghelo, Kalubhar, Vagad, Keri, Goma, Malan, Kalbi and Padak.

Climate

The climate of the study area is characterised by a hot summer and general dryness except in the coastal region. The year may be divided into three seasons. The winter season from October to February followed by the summer season form March to June. July to September is the monsoon season.

The period from March to May is one of continuous rise in temperature. May is generally the hottest month, the mean daily maximum temperature at Bhavnagar being 40.7°C and that of Mahuva 35.9 C. Hot scorching winds blow during the summer season and day temperatures of the order of 40°to 43°C is quite common.

With the onset of the south west monsoon by about the middle of June and sometimes much later, the day temperature decreases a little. With the progress of the season, however, both day and night temperatures begin to decrease till January which is the coldest month when the mean daily maximum temperature is about 29° to 30° C and the mean daily minimum about 12°to 15° C.

About 90 % of the annual rainfall in the district is recieved during the south-west monsoon months from July to September, July

being the raniest month. The variation in the rainfall from year to year is large.

Flora and Fauna

Out of the total area of 12108 sq.km. in the district an area of about 138 sq.km. is covered by forest whioh can be classified as dry deciduous scrub forest.

The following species are prominently noticed in this forest. Acacia senegal (gorad), Acacia arabica (babul) Gymnosporia montana (viklo), Balanites roxburghi (tingol), Boswellia serrata rosel (salai). Anogeissus latifola (dhavdo), Terminalia tomentosa (sajad) etc. Apart from Saru and Gando Baval. Teak, Deshi Babul, Arduso, Semal etc. are being raised in various places. The district is famous for Mangoes and Pome Granates. In addition to these the other fruit trees seen are Coconut, Gauva, Chikoo, Banana and Arecanut.

Though the district does not have much area under forest, it still has wild animals like Panther, Nilgai, Spotted Dear, Wild boar, Hyaena, Wolf, Jackal, Hare, Chinkara, Black buck etc..

Communioation and Transport

Bhavnagar city is the district headquaters and is well oonnected with all the important cities and towns of Gujarat by bus services.

The state highways passing through the district are i) Rajkot-Bhavnagar, ii) Bhavnagar-Talaja-Mahuva, iii) Bhavnagar-Ahemedabad iv) Vallabhipur-Umarla-Dhola-Ranghola.

The bentonite pockets in the study area are approachable from Bhavnagar by metalled and dirt roads.

The existing rail links in the district are i) Surendranagar-Botad-Bhola-Bhavnagar, ii) Ahmedabad-Botad, iii) Botad-Jasdan, iv) Ningala-Gadhada-Swaminarayan, v) Sihor-Palitana, vi) Dhola-Jetalsar-Porbandar, vii) Dhasa-Rajula-Mahuva and viii) Bhavnagar-Talaja-Mahuva.

Because of the fairly long coastline the district possesses four working ports of which Bhavnagar port is an intermediate port, while Mahuva, Gogha and Talaja are major ports.

A regular scheduled air service passes daily through Bhavnagar and flying between Bombay-Bhavnagar-Ahemedabad.

Recently a ferry service has been introduced between Gogha-Bombay and Gogha-Surat.

Purpose and Soope of Investigation

The origin of bentonite has been worked by many geologists world over. The common and accepted origin of bentonite is that it has formed by the alteration of volcanic tuff or pyroclastic material. It can also form by the hydrothermal action on volcanic material. Reports indicate that basalts have yielded trioctahedral montmorillonites (biedellite, montmorillonite and nontronite), by the alteration of olivine/pyroxene and plagioclase feldspars, respectively (Craig and Loughnan, 1964). Montmorillonite is known to form at present by the weathering of basic igneous rocks in an alkaline environment in the presence of

magnesium (Millot, 1970). Montmorillonite may form by the terrestrial and subaqueous alteration of basic volcanic material (Ross & Shannon, 1926; Brindley, 1951; Millot, 1970). The presence of glass shards is the most direct and convincing evidence for the association of montmorillonite with such igneous activity and is reported from some recent sediments (Millot, 1970). In the marine environment volcanic glass undergo hydrolisis to give rise to montmorillonite and the excess silica produced by such reaction may appear in the sediment as crystoballite (Brindley, 1951).

The present study was undertaken with an aim to establish the geology, mode of occurrence and genesis of the bentonite deposits and to determine the standards for industrial applications. This involved systematic geological mapping of the entire bentonite bearing areas, followed by the detailed investigation of the laterite profile exposed in numerous pit, mine and river sections. These features pointed out the mode of occurrence of the bentonite deposits.

Various horizons in the profiles were plotted and samples were collected systematically. These samples were subjected to detailed laboratory investigations using XRD (for quantitative and qualitative minerological estimations), ICEP (for major and trace element studies). These investigations pointed out the behaviour of different minerals and the chemical elements within the profile, which in turn were useful in preparing a genetic model for the bentonite deposits. Tests for loss on drying,

swelling index, gel formation value, pH, base exchange capacity, specific gravity, filtration loss, fineness (both dry and wet) and moisture content were carried out to determine the industrial utility of the bentonites.