CHAPTER - 1

INTRODUCTION

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BACKGROUND INFORMATION

The arid and semi arid terrains in the north western India, "The Great Desert of Thar" attains vast significance from the point of view of its past geological history spanning between Pleistocene and Recent i e. Quaternary period During this period, the area has witnessed manifold transformations ranging from well-knitted perennial drainage, blooming river valley civilization, fertile pastoral land, to a barren, hostile terrain of today The modifications brought about by the gradual /sudden changes in climatic, geomorphic, edaphic and biotic processes no wonder attracts a wide spectrum of scientific commonwealth since the last century, to unravel the conundrum of the natural processes that have been sculpturing the Indian desert.

The evidences of these terrain ramifications are strewn across the Thar desert in the form of disrupted palaeochannels, playas, stabilized and active dune complex, duricrusts, neotectonic signatures and archaeological artifacts etc. Besides these direct as well as indirect evidences, the evolutionary history of the Thar desert remains with full of gaps and embroilment due to inadequate contributions related to the geological aspects

The Quaternary geological records in the Thar desert comprise diverse sediments derived from the confederacy in action by fluvial - lacustral - aeolian- eluvial and residual processes, all bearing the signatures of the past climatic modifications it had underwent

Amidst the different tools that have been employed for the past few decades to unravel the past climatic changes in the Thar, fossil dunes and residual deposits such as calcretes and ferricretes have gained more significance by virtue of the processes related to their genesis and development

In addition to the palaeoclimatic significance in the present day context, 'Thar desert' being a border area between India and Pakistan it is strategically very sensitive. To support lives in this most populous desert as well for guarding the nation's security a good network of logistic support is a pre requisite. But, construction of roads in this rugged, sandy terrain is persistently hampered due to the chronic deficiencies such as paucity of local, standard paving materials, scarcity of water, rapid dune migrations etc., which in turn pose a major threat in manning the country's security

Realizing the scientific interest as well as the present necessity, the author opted this research problem covering the fundamental aspects i e genesis, palaeoclimatic significance and applied aspect i.e geotechnical appraisal of the calcretes and ferricretes Thus, in this study, the author endeavoured to understand the importance of calcretes and ferricretes in palaeoclimatic studies as well as their potentiality as a road paving material

AIMS AND OBJECTIVES

The present studies on the calcretic and ferricretic duricrusts of the Thar desert aims at

(i) To study the genesis, development of calcretes and ferricretes and their utility in understanding the palaeoclimatic changes.

(ii) To appraise the geotechnical feasibility of these duricrusts in the road construction as pavement aggregate.

The aims of the study are achieved through following objectives viz.

(i) To map the distribution of calcretes and ferricretes in space through ideally exposed sections

(ii) To bring out the chemistry, mineralogy, micromorphology of calcretes and ferricretes.

(iii) To illustrate the significance of calcretes and ferricretes in deciphering micro-environmental changes leading to palaeoclimatic implications.

(iv) To evolve models for the genesis and development of these duricrusts.

(v) Evaluating the geotechnical characteristics of calcretes and ferricretes in connotation to their utility as road paving aggregates.

THE STUDY AREA

LOCATION AND EXTENT

The study area predominantly encompasses the Marwar, Barmer and Jaisalmer basins covering the semiarid-arid terrains of the western and central part of the desert (Figure 1 1) The study area is bounded between the latitudes N 25° 30' - 28° 00' and longitudes E 70° 30' - 73° 30'. Politically the study area falls within the districts of Barmer, Bikaner, Jaisalmer, Jodhpur and Nagaur districts of Rajasthan. The study area falls within the Survey of India toposheet nos. 40 I,J,K,L,M,N and 45 A,B,E,H.

COMMUNICATION

While well paved roads connect the important towns falling within the study area, most of the villages lack in paved roads The road density and networking still remains inadequate to reach most of the places, a feature not supposed to be for a sensitive border state Many of the unpaved roads are not motorable during monsoon period due to uneven settlement of the subgrades and flash floods through nallahs. The rail track networking also confines mostly to the important towns like Jodhpur, Jaisalmer, Barmer, Bikaner, Pokhran etc

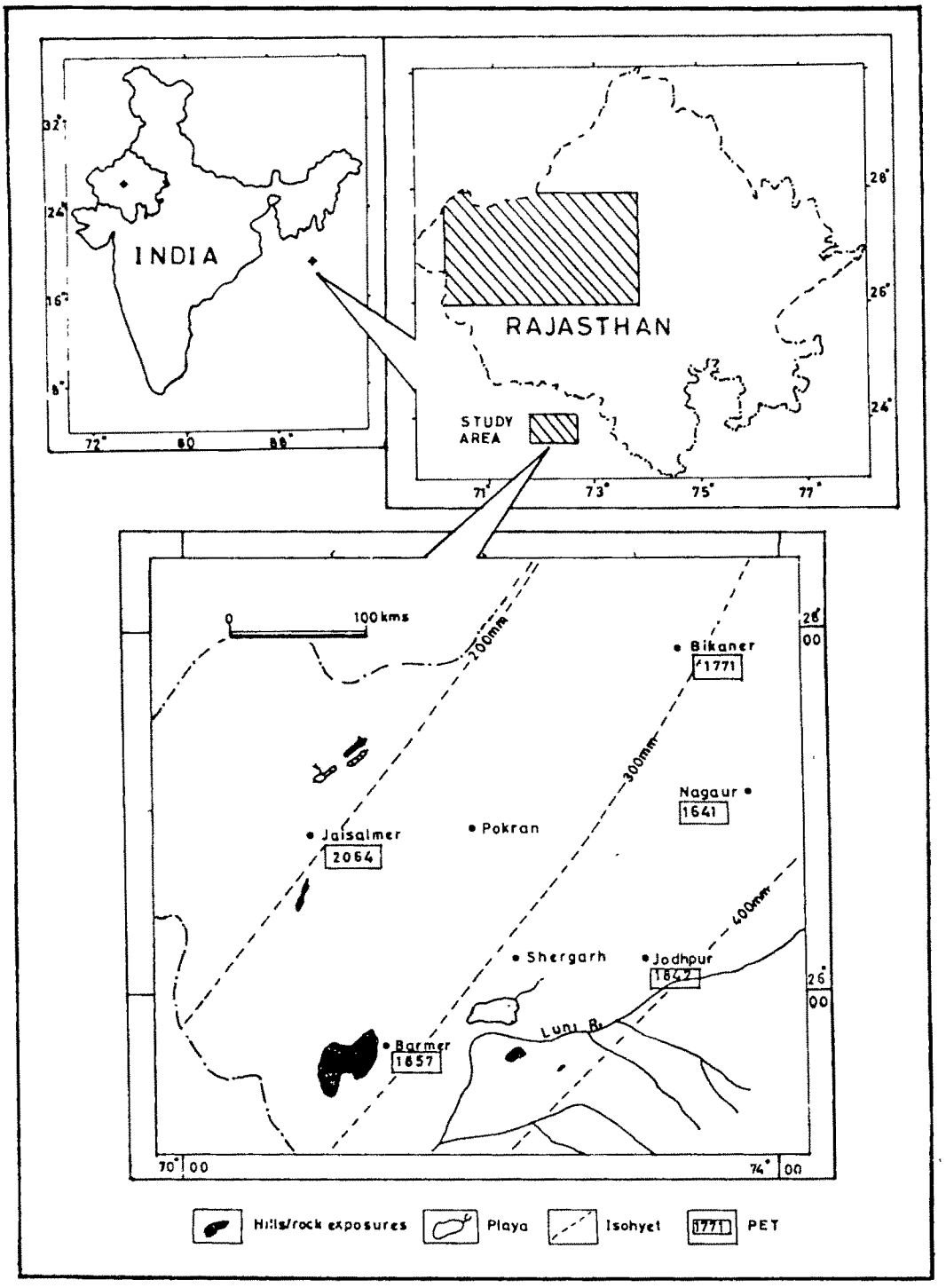

Fig. 1.1. Location map of the study area.

PHYSIOGRAPHY AND DRAINAGE

Physiographically the study area comprise vast diversified landforms, from hills - inselbergs - rocky / gravelly pediments, colluvial plains-alluvial plains - dunal complex - saline depression to flat plains The prominent hills and inselbergs of rhyolite and granites are confined to the southern and south eastern parts of the study area. These hills occasionally reach an altitude of about 500 m AMSL But, average elevation of the study area is around 200 m AMSL with a regional slope towards west and southwest. The pediment colluvial plains predominantly are associated with these inselbergs at the southern and western parts of the area. The vast stretches of dune complex includes both stabilized and active dunes of various kind. In general the height of the stabilized dunes vary from 10 to 60 m while the active ones are from 2 - 12 m. Besides a few seasonal streams and nallahs, the ephemeral Luni and its tributaries forms the only major drainage system within the area. The drainage is predominantly internal type with streams loosing themselves within the vast sandy plains and playas.

GENERAL GEOLOGY

Geologically the Thar desert display a well documented stratigraphic record spanning from Archaean to the Recent time. The generalized litho - stratigraphy of the area based on the available data is given in the Table 1.1

Lithology	Thickness (m)	Geological Era
Windblown sands, fluvial, lacustrine sediments, soils, calcretes etc.	50 - 300	Quaternary
Clays, evaporites, shales, sandstones, limestones	250 - 500	Tertiary
Sandstones, limestones, shales and grits	300 - 1000	Mesozoic
Sandstones, conglomerate, limestone, shale, boulderbeds.	--------	
Rhyolites, granites, amphibolites, quartzites, marble (Delhi Supergroup)	--------	Pre-Cambrian
Unclassified gneisses and granites (Bhilwara Supergroup / BGC)	--------	Archaean

TABLE 1.1 GENERALISED LITHO-STRATIGRAPHIC SEQUENCE OF THE STUDY AREA

METEOROLOGY

The climate of the study area is predominantly arid, except the eastern parts where it transits to semi-arid. The study area is characterized by erratic monsoon,prolonged summer and short span of winter. In general, the area is characterized by three distinct seasons viz, the summer - (March to June), the monsoon (July to September) and the winter (December to February). October and November months are post monsoon seasons, a period of transistion from monsoon to winter.

TEMPERATURE

Extreme variations in temperature, both diurnal and seasonal are characteristics of the study area The temperature extremes vary from as low as 2° C (in winter) to as high as 51° C (in summer). In general winter season has a mean diurnal temperature variation from 14°- 16°C The mean maximum temperature during summer varies from 40° to 42°C, but occasionally during May or June it reaches upto 48° - 50°C.

WIND

The dominant winds are generally from the southwest and west during summer and monsoonal seasons with a relative speed of 5.1 km/hr to 11 7 km/hr. Dry, hot and dust raising winds with a speed about 25 km/hr blow in the western parts of the study area during May and June. With the onset of winter the wind direction slowly changes from west, south west to north, northeast

HUMIDITY

One of the interesting features of the study area in contrast to other deserts is its high relative humidity. Though the rainfall is less, the humidity during monsoon months is as high as that of the sub humid areas. The winter and summer periods have low humidity. The relative humidity range between 25 & 85 %.

EVAPORATION

The mean annual evaporation of the study area is about 431.8 cm The highest rate of evaporation prevails during the months of May & June and lowest during December - January. The summer months account for about 50% of the annual evaporation, 20% of the evaporation during monsoonal period and the rest 30% in other months.

RAINFALL

About 90% of the rainfall the area receives confine to the monsoonal season. The mean annual rainfall of the study area varies from 100 mm to 400mm with a general decrease towards west Further west of Jaisalmer the mean annual rainfall is below 100mm.

FLORA

The biotic habit of the study area is typical of any arid, semi-arid terrains. The study area is sparsely vegetated and has very limited number of trees, but dominated by shrub species, among which Xerophytes constitute more than 60 %.

The thorny trees comprises *Prosopis cineraria, Capparis decidua, Acacia ceucophloca, Prosopis julifora,Acacia catechue, and Salvadora sp.* The salient vegetation types, characteristic of diverse physiography are :

Calligonum Leptadenia type - Sand dunes and sandy undulations
Suaeda fruticosa type - Margins of saline lakes
Prosopis - Capparis -Zizyphus - Flat alluvial plains
Prosopis-Tecomella - Deep sandy plains and low dunal areas
Salvadora oleoides- Prosopis - Deep, flat alluvial plains.

FAUNA

The study area supports rich and diverse faunatic life both domestic as well as wild. The domesticated animals include sheep, goat, camel and cattle. The most prevalent among

the wild animals include black buck, chinkara, nilgai, desert hare, fox, great Indian bustard, rodents snakes, peacocks and a wide spectrum of insects.

APPROACH AND METHODOLOGY

Considering the perplexing terrain with poor logistic facilities and basic resource constraints the author's endeavour to solve the intricate, but potential research objectives necessitated to design and adopt a special approach cum methodology As elucidated before that the area has so far been investigated in detail by archaeologists, geomorphologists and palynologists, the authors attempt to decipher the palaeoclimatic importance and geotechnical characteristics of duricrusts are the first of its kind from the geologist's point of view. The multidisciplinary approach and methodology that have been adopted are in the following phases.

PHASE I

Preparation of data base through compilation of available literature pertaining to the different aspects of the research problem Preparation of base, regional geological and geomorphological maps, mapping the distribution of duricrusts etc.

PHASE II

Involves detailed fieldwork along selected traverses with special emphasis on all field based studies for the duricrust viz. mode of occurrence, types, distribution etc. Systematic inventory of soil, duricrust profiles, and sampling (disturbed, oriented, undisturbed) for the detailed laboratory studies Special field based tests and undisturbed core sampling of duricrust for geotechnical studies also form a part of this phase.

PHASE III

Involves detailed laboratory studies through advanced, high resolution instrumentation techniques such as EPMA, ICP-MS, AAS etc on the following lines.

(i) Detailed chemistry on major oxides, trace elements (by AAS) and REE (by ICP-MS) to understand the microenvironmental changes that prevailed during the formation and development of duricrusts

(ii) Studies on the mineralogy through XRD and thin section studies for estimating the rate of weathering and neoformations.

(iii) Preparation of soil thin sections (Ramakrishnan and Tiwari, 1996a) and subsequent micromorphic studies to investigate the pedological significance and to establish the sequence of duricrust development.

(iv) Sub microscopic studies (EPMA) to monitor the stability of minerals during duricrust formation.

(v) Geotechnical evaluation of duricrusts through standard tests leading to categorization of duricrusts for desertic road pavements and for estimating the pavement thickness

(vi) Statistical analyses of chemical and geotechnical parameters.

(vii) Compilation and correlation of laboratory and field data.

(viii) Evaluating the potentiality of duricrusts in palaeoclimatic studies and its geotechnical utilities.

THE THESIS

The studies and findings of this thesis comprise two parts. Part I (chapters I to VI) pertains to the genesis and palaeoclimatic aspects of calcretes and ferricretes; Part II (chapter VII) is about the geotechnical efficacy of these duricrusts as a pavement aggregate. Chapter wise details are given as under :

Chapter I Introduction covers the background informations, aims and objectives, general description of the study area and adopted approach and methodology.

Chapter II Litho - Stratigraphic and Tectonic Framework incorporates the regional pre-Quaternary geology in general and Quaternary geology in detail and tectonic setup of the study area

Chapter III Geomorphology appraises the physiography, drainage, landform features and Quaternary morphostratigraphy.

Chapter IV Duricrusts deals with the terminology, classification and general distribution of different duricrusts in the study area. This chapter also incorporate **calcretes** their distribution in the study area, mode of occurrence, chemistry, mineralogy, pedological characteristics, classification and models for their genesis.

Chapter V Ferricretes deals about the iron duricrusts, their mode of occurrence, mineralogy, chemistry, micro - morphology, types and mode of formation.

Chapter VI Duricrusts and Palaeoclimatic Implications elucidates the Quaternary palaeoclimatic ameliorations, applications of pedostratigraphy, utility of calcretes and ferricretes in understanding micro and macro environmental changes.

Chapter VII Geotechnical Appraisal discusses in detail about the significance of a good road network, difficulties in pavement constructions in the study area and evaluation of geotechnical efficacy of calcretes and ferricretes in road pavements.

Chapter VIII Summary summarizes the different findings of the study.