CHAPTER  I

INTRODUCTION
The Aravalli craton forms the westernmost part of the Indian shield comprising Archaean basement of Banded Gneissic Complex (>3500 Ma), Proterozoic meta-sedimentary and meta-volcanics of Aravalli and Delhi Supergroups, Late Proterozoic felsic Malani Igneous suite, and various sedimentary sequences ranging in age from Late Proterozoic to Holocene. Also present are granites ranging in age from 2950 to 740 Ma (Naqvi and Rogers 1987, Chaudhary et al. 1984). Much of the post 2000 Ma geohistory of Aravalli craton in general revolves around the tectono-orogenic evolution of Aravalli-Delhi fold belt (ADFB), specially the successive development of various sedimentary basins towards west (Fig-1).

The Bikaner-Nagaur basin juxtaposed to ADFB is the oldest (Late Proterozoic-? Early Cambrian). The earliest sediments deposited in this basin largely over the volcanic basement of Malani Igneous suite and partly on the ADFB rocks were designated as Marwar Supergroup (Pareek 1984). Next sedimentation cycle in this basin commenced in Permo-Carboniferous and Permian times with the deposition of arenaceous rocks of Bap and Bhadaura Formations (Misra et al. 1993).

This study deals with the lower most part of Bikaner-Nagaur basin i.e. Jodhpur Formation which comprises
Fig. 1. Geological map of the Aravalli craton and the western Rajasthan shelf (modified after Das Gupta and Chandra 1978; Srivastava 1988). 1, Banded Gneissic Complex; 2, Aravalli Supergroup; 3, Delhi Supergroup; 4, Unclassified Proterozoic Sedimentaries; 5, Erinpura Granite; 6, Malani Igneous Suite; 7, Jalore and Siwana Granites; 8, Bikaner-Nagaur Basin; 9, Barmer Basin; 10, Jaisalmer Basin; 11, Alluvium; F-F, Faults.
mainly of sandstones with subordinate shales and conglomerate. The Jodhpur Formation was deposited during a regressive phase in deltaic, beach and braided fluvial environments (Chauhan et al. 1991).

LOCATION OF THE STUDY AREA

The study area is located in and around Jodhpur city in between the north latitudes of 26°25’-26°13’ and longitudes of 72° 50’ - 73° 07’, in the state of Rajasthan (Fig.2). The studied Jodhpur sandstones are exposed along with the underlying volcanics in uplifted horst blocks trending NE-SW. On the flanks of the horsts, sandstones form gently rolling hills and their excellent fresh exposures are found in a large number of sandstone quarries. The sandstone samples were collected from several sections namely Jodhpur Fort, Wireless Hill, Punjala, Masuria, Gangana, Kabir Nagar, Fidusar Diversion, Sursagar, Deoria, and Motisar Bhakar Sections (Fig-2).

DEFINITION OF THE PROBLEM

Sedimentary rocks are our principle source of information about past conditions on the Earth surface giving vital clues about exogenous as well as endogenous processes which lead to the evolution of the crust. Clastic rocks specially sandstones have also been extensively used as clues to their source regions from the very inception of
Figure 2. Geological map of the study area, the Jodhpur city (after Chauhan et. al. 1991).
sedimentology in general and sedimentary petrology in particular. The last two decades saw a many fold increase in the studies of sandstone texture and composition with ever improving methodology and refinement in the interpretation of the data base. The main emphasis of the sandstone petrography has been on the detrital composition as well as identification of various diagenetic phases, their paragenesis and its bearing on porosity evolution.

The provenance studies of the sandstones are the most celebrated and sought after investigations coming next in importance to the depositional environment analysis (Pettijohn et al. 1987). The empirical studies on the detrital composition, discerned by petrography gave much impetus to evolution as well as evaluation of a source region and are still in active use. Though some modern techniques employing dating of the heavy detrital mineral grains and trace element chemistry to interpret the provenance setup are in use but their access to the day to day studies is limited and they need much expertise (Compston et al. 1985; Compston and Pidgeon, 1986; McLennan et al. 1990). With the advancement made to the understanding of the crustal movements and global distribution of rock types defined by plate tectonic model sedimentary processes and result were also viewed and explained in the context of plate tectonic
setting. Krynine (1942) interpreted detrital mineral composition in terms of then prevalent geosynclinal cycle concept. More recent synthesis of sandstone composition and tectonic setting has resulted into various discriminating diagrams, notable of these given by Dickinson and Suczek (1979) Ingersoll and Suczek (1979), Dickinson (1985), Valloni (1985) etc. These ternary diagrams were found very helpful for almost 75% of the studies on sandstone suites and resulted into better identification of provenance and tectonic settings. After the coining of the term "petrofacies" by Gilbert and Dickinson (1970), Swe and Dickinson (1970) and Dickinson and Rich (1970), defined in terms of detrital composition, the sandstone petrofacies have been in extensive use to interpret the source region setting of a sedimentary province and regional correlation (Stanley 1976; Ingersoll, 1978, 1990; Dickinson et al. 1982, 1983; Ingersoll and Suczek 1979; Thornburg and Kulm 1987 etc.). The correlation between tectonic setting and sandstone petrofacies is sometimes found to be off the track due to the use of varying methods in grain-point counting and classification of modes. Moreover, an 'erroneous' population may result from over working of detritus by the various sedimentary processes. These petrofacies need much more close scrutiny taking into account the involved processes. (Wolf
Diagenesis is an integral part of the evolution of a sedimentary deposit which includes compaction and cementation, which lead to transformations of freshly deposited sediments into a well lithified rock. The diagenetic studies are of fundamental importance in industrial context of hydrocarbon and water reservoir evaluation apart from fundamental academic studies. Optimum oil recovery especially from sandstone reservoirs led sedimentologist to look more carefully to the diagenetic status and regional diagenetic facies. The increasing oil prices, conservation and increased exploration for new oil reservoirs gave much impetus to the diagenetic studies by various modern techniques to understand the complex and intricate diagenetic processes and reactions. The petrographic microscope is still the most useful and handy tool specially for study of sandstone and a good data base can be generated about diagenetic textures, fabrics, extent of compaction and authigenic cements. Other methods include porecasts, scanning electron microscopy (SEM), microprobe, cathodoluminescence, X-ray diffraction and stable isotopes analysis (Bjorlykke 1983). Most of the work carried out for sandstone diagenesis deals with various phases of diagenesis.
and has an inherent aspect of porosity evolution and prediction based on empirical studies on modern unconsolidated sands (Bird and Weyl 1973; Rittenhouse 1971; Chilingarian et al. 1975; Dapples 1967; Wolf and Chilingarian 1976; Angevine and Turcotte 1983; Scherer 1987; Bloch 1991; Atkins and Mc Bride 1992). In the last decade much work based mainly on petrographic analysis supported by additional studies by SEM and cathodoluminescence has been carried out to interpret the compaction - cementation processes and the porosity evolution (James et al. 1986; Houseknecht 1987, 1988; Chilingarian 1983; Fuchtbauer 1983; McBride 1989; Lundegard 1992).

AIM AND SCOPE OF THE STUDY

The sandstones under study constitute the Jodhpur Formation which is the lower most unit of sedimentary rock sequence deposited in Bikaner - Nagaur basin during Late Proterozoic-? Early Cambrian. These rocks overlie the basement complex comprising of Delhi Supergroup and Malani Igneous suite of rocks, with a pronounced unconformity. Previously these rocks were termed as "Trans Aravalli Vindhysans" on the basis of gross similarity in lithology to the Vindhyan rocks (1400 - ? 500 Ma)• lying east of ADFB (Pascoe 1959). After the underlying rhyolites of Malani Igneous suite were dated 745+ 10Ma by Crawford and Compston
Various workers have suggested that deposition of the Jodhpur Formation commenced, in Late Proterozoic in entirely separate basin with much closer affinity to Tethyan rather than to Vindhyan sedimentation (Pareek 1981b, 1984). Apart from the stratigraphic status, tectono-sedimentary evolution of the western Rajasthan shelf as a whole, comprising of various other sedimentary basins mostly floored by Malani igneous suite of rocks, is also not well understood.

Oil and Natural Gas Corporation (ONGC) Ltd. of India made several forays in the last decade for the preliminary investigations of western Rajasthan basins in quest of hydrocarbon reserves. ONGC has published a lithostratigraphic document (Misra et al. 1993) on the Bikener - Nagaur basin and has classed this basin as category III type of basin which is a geologically prospective basin and needs an exhaustive sedimentological data base for prognosis. Till now generalized sedimentological studies carried out in this basin include basin configuration and stratigraphy (Pareek 1981b, 1984; Biswas et al. 1993; Misra et al 1993). Studies on Jodhpur sandstone include lithofacies, palaeocurrent and depositional environment analysis (Verma 1970; Awasthi et al. 1977; Awasthi and Prakash 1981; Chauhan et al. 1991). The tectono-provenance of terrigenous clastics and tectono-sedimentary aspects of the
basin in general and of Jodhpur sandstone in particular have not been undertaken prior to this study to the best of my knowledge.

This study particularly aims at detailed petrographical analysis of Jodhpur sandstones to ascertain the petrofacies evolution and diagenetic status. Petrofacies identification and its interpretation has been made to resolve the tectono-sedimentary evolution of the studied sandstones and its tectonic connotations in terms of basin evolution. Diagenetic studies of these sandstones include recognition and mode of occurrence of various cementing materials, extent of compaction, porosity distribution and evolution. Diagenetic process were also studied with a view to evaluate their effects on detrital composition of the sandstones and consequently on the interpretation of provenance.

METHODS

The studied sandstones were deposited during a transgressive phase (Chauhan et al. 1991). The deposition commenced with deltaic sedimentation followed by beach and braided river sedimentation. The sandstones of all these environments are well exposed at different locales with their distinctive lithofacies. Sample collections were made from all these lithofacies from outcrop sections. The samples were
collected at an interval of one to two meters generally. A detailed petrographic analysis was carried out for studying textural attributes which include grain size parameters and grain shape parameters. For this purpose three hundred points were counted with spacings greater than the mean size of the grain, to generate basic data base to be used in the studies intended. Petrofacies analysis was performed by counting four hundred points from each thin section according to Gazzi-Dickinson method adopted by Ingersoll (1984). Detrital modes were also classed as per Folk's (1980) scheme of detrital classes and were used for sandstone classification and for identifying the parent rock assemblage. A separate point counting of two hundred points for diagenetic studies were made to identify various authigenic phases and to estimate compactional parameters and burial depth for the studied sandstones.