Pottery enjoys an eminent position in Neolithic and Post-Neolithic archaeological studies because it is the most abundantly available artifact to the archaeologist. The importance of pottery, which has been described as "an alphabet of archaeological chronology" is very well explained by Myers. He says "it provides...... exceptionally copious materials, and as every fragment is an original work of art, the evidence of pottery justifies broader and surer generalizations than almost any other human document; every potsherd in any waste heap brings the response of somebody's hand and brain to somebody's need, at the same time, individual, communal, industrial and aesthetic...... The utter uselessness of pottery, once broken, except as extemporized scrapers, or as builder's ballast to level a new floor, is the main cause of its archaeological value; for, when broken, pottery is cast out of a settlement, there it is allowed to lie and accumulate layer over layer, later over earlier, so that sequence dating derived from such a rubbish heap is as secure as the sequence of the fossil in the sedimentary rocks, and of the highest value as evidence for the change of style, that is to say, of the notions, industrial and aesthetic, of successive generations of makers and breakers of pottery.
As breakage and replacement are constant, clay almost ubiquitous, and pot-transport risky, the pottery series in any settlement is exceptionally continuous and coherent; the smallest changes are recorded infallibly, directly and immediately and every other nonperishable object cast upon the same waste heap is conserved automatically in a stratified order, and can be dated by potsherds around it, between older ones below, and later ones above". (Myers 1934: 70-71).

In the Neolithic period the art of shaping clay and transforming that shape into a useful form which is unaffected by water, as vessels or other useful objects, was known to man. The making of pottery can be considered as a creative art. Besides meeting daily needs of the people the potter also fulfilled his irresistible urge to create new forms and decorate them with new painted designs. The designs or decorations on them were meant to improve their appearance.

At many of the archaeological sites pottery relics are the only evidence of the bygone human activity. Each cultural levels provides different types of distinctive pottery. From time to time pottery also underwent changes in fabric, form, surface dressing and the pattern of decorations on them. The study of pottery by an archaeologist in order to establish the cultural sequence of his site is mainly based on the shape, colour, texture and the pattern of designs on them. However, the archaeologist has rarely
paid any attention to the study of technology of pottery manufacture. The present thesis is an attempt to reconstruct the techniques employed in the manufacture of Harappan period pottery in Gujarat. Before looking into the details of the research problem, it would not be out of place here to say a few words about the Harappan Civilization since the samples analysed belong to this civilization in Gujarat.

The Harappan Civilization which is also known as the Indus Valley Civilization, flourished in the third millennium B.C. in the north-western part of the Indo-Pak sub-continent. It is well known for its various distinctive cultural features. The sites of this culture are widely distributed in the sub-continent. It extended far beyond the limits of the Indus Valley: from Suktagen-dor on the sea-board of south-western Baluchistan to Alagirpur in the upper Ganga - Yamuna doab in Uttar Pradesh and from Shortugai (in Afghanistan) in the north to Diamabad, on the right bank of the Pravara river, a tributary of Godavari in the south. Agriculture was the backbone of this civilization. Some of the striking features of this civilization are: remarkable town planning including sophisticated drainage systems, well built brick structures using both kiln burnt and mud bricks, attractive terracotta figurines, well developed copper metallurgy, art of carving stone sculptures, occurrence of inscriptions on seals and pottery which reflect the literacy of the people, certain religious practices,
use of ornamental beads made of semiprecious stones and steatite, domestication of animals and distinctive pottery made of well refined and well fired clay. Most of these pottery were wheel made.

Gujarat is one of the major regions beyond the Indus Valley, which represents the strong Harappan traditions. Excavations at major sites like Lothal (Rao 1979 & 1985), Rangpur (Rao 1963), Surkotada (Joshi 1972), Nageswar (Hegde et al 1985), Nagwada (Indian Archaeology 1985-86) and many other sites have revealed an impressive picture of the distinctive aspects of this civilization in Gujarat. The \( ^{14}C \) dates for Lothal ranges from 2080 ± 135 BC to 1800 ± 140 BC (Rao 1979: 39), Surkotada 2315 ± 135 BC to 1600 ± 110 BC (Agarwal 1984: 274) and for Nagwada 2140 ± 80 BC (Indian Archaeology - 1985-86). The sequences of Harappa Culture in Gujarat is well defined at Rangpur (Rao 1963). Here the mature Harappan tradition in Period IIA is characterised by the Indus Script inscribed on pottery, tools made of chert, Harappan triangular terracotta cakes, cubical stone weights on the Indus scale, baked brick and mud brick architecture, drains and the Harappan ornamental stone beads.

In the deposits succeeding this nature phase in II B and II C a deterioration in the quality of structures is observed. The cubical stone weights, terracotta triangular cakes, perforrated jars, s-profile jars, the Indus goblets
and several other distinctive ceramic forms disappear. The superior Harappan pottery become coarser in texture and tend to be poorly executed. The graffiti on pottery shifts from crisp Indus characters to almost indistinguishable scratching. Flint tools are replaced by tools made by chalcedony and jasper. The final phase of this civilization, Rangpur III, is marked by the disappearance of all distinctive Harappan traits and occurrence of Lustrous Red Ware and increase in the frequency of black-and-red ware.

The "typical" Harappan pottery is made of well refined clay. It is thrown on the wheel and well baked. The uniformity in the quality of these pottery in all Harappan sites is well known. Goblets are the only hand made pottery among the Harappan wares. Red Ware constitutes a great bulk of Harappan pottery. Besides, Buff Ware, Grey Ware and black-and-red ware are encountered in the Harappan sites in Gujarat. The percentage of painted pottery is small at all Harappan sites. The paintings occur as black on red surface, chocolate or purple black on buff, white or creamy on the black surface of the black-and-red ware. Grey Ware does not have any paintings and its percentage is very small. Normally two kinds of fabrics are encountered among the Harappan Pottery namely, fine and coarse. Most of these pottery are dressed by the application of a slip. The major shapes of these vessels are dishes, dishes-on-stand,
jars of different variety, s-profile jar, perforrated jar, vases, basins, pans, lids, goblets, bowls, cups, beakers, tumblers and many other local shapes.

The painted decorative designs seen on the Harappan pottery are mostly geometrical. Besides these, faunal and floral motifs are also encountered. Geometrical designs are dominated by overlapping circles and their manifold permutations and combinations. The floral motifs comprise palm and acacia tree, plants and leaf motifs dominated by pipal leaf. The faunal repertoire of the painted designs are very poor, comprising ibex, goat, doe, jungle fowl, antelope, snake etc, dominated by peacock. Incised decorations are very limited both in its variety and application and is confined to the inside bottom of the big pans, and the central interior of the dish-on-stand.

Generally the archaeological study on pottery is restricted to the typology of different wares and the decorative motifs seen on them. Various aspects of the decorative patterns seen on the Harappan Pottery are extensively studied by Starr (1941). Manchanda (1974) has given more importance to the typological variations of the pottery. Similarly all the archaeological reports give much importance to the study of typology and decorative motifs of the pottery.
But so far very few attempts have been made to study these pottery using scientific methods to reconstruct their production technology. Chemical analysis of the ceramics have been done for some specimens from Mohenjo-daro by Hamid (Marshall 1931: 689), Harappa by Mohammad Sana Ullah (Vats 1974: 468), Rangpur by Lal (Rao 1963: 133-134) and Lothal by Lal (Rao 1985: 461-474). Plenderleith's microscopic examination of Reserved slip Ware from Mohenjo-daro also requires special mention (Marshall 1931: 692). Another important study that has been carried out on ancient Indian pottery is by Hegde (1978). Similarly an attempt is made by Krishnan (1982) to understand the chemical composition of the pigments used in the decoration of late Harappan pottery from Gujarat.

This thesis is an attempt to reconstruct the various stages involved in the manufacturing of the pottery of the Harappa Culture in Gujarat. These various stages include collection of clay, preparation of the clay paste, shaping of pots, application of slip over them, decorating them with different pigments, drying them under sunlight and finally baking them in a kiln. For this work Pottery specimens from three excavated Harappan sites of Gujarat, viz., Vagad, Nageswar and Ratanpura were chosen and studied using various scientific techniques. The pottery specimens chosen for studies included Red Ware (Sturdy Red Ware, micaceous red ware, coarse red ware), Buff Ware, Chocolate
The main objectives of the present investigation may be enumerated as follows:

(a) to know the source of the clay used for making the pottery and to understand whether these pottery were made locally or imported;

(b) to understand the quality of the clay paste and the amount of labour put in by the ancient potter in elutriating the clay to produce different fabrics of the Harappan pottery;

(c) to know the composition of different decorative pigments and slips and then to identify the raw materials that were used for decorating the wares;

(d) to understand the techniques of baking the pottery in a kiln;

and

(e) to determine the baking temperature of the pottery.

In order to find answers to these questions studies using thin-section microscopy, x-ray diffraction, energy dispersive x-ray microanalysis, scanning electron microscopy and differential thermal analysis have been employed.
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