International Journal of Humanities and Social Science Invention (IJHSSI)
ISSN (Online): 2319 – 7722, ISSN (Print): 2319 – 7714
www.ijhssi.org ||Volume 13 Issue 10 || October 2024 || PP. 115-124

A Comprehensive Study of the Origin, Evolution, and Perpetuation of Indian Glass Beads

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Abstract- *This study explores the historical evolution and technical advancements in Indian glass bead manufacturing. It traces the origins of this craft in India, detailing the techniques used by artisans and the transmission of skills across generations. By examining the chemical composition of glass and its raw materials, the study draws connections between archaeological findings and textual references. It aims to demonstrate the continuity of this knowledge through ethnoarchaeological research, addressing the gap in archaeological evidence. The study also highlights dominant glass-making practices in three key production centres, with a particular focus on the Banaras Beads Limited Glass Manufacturing Centre. This case study aims to understand the persistence of glass bead production from ancient times to the present.*

The production and trade of glass beads in India exemplify the country's rich cultural heritage and enduring craftsmanship. This comprehensive study traces the origins, evolution, and perpetuation of Indian glass beads, from ancient times to the present day. Indian glass bead production, with roots dating back thousands of years, has evolved through various historical phases, influenced by technological advancements, trade dynamics, and cultural exchanges. The study delves into distinct production techniques, regional variations, and the socio-economic impact of the glass bead industry. Beads serve as a medium of human expression, and the enduring tradition of glass bead production in India highlights this form of artistic and cultural communication, showcasing the intricate craftsmanship and vibrant heritage of the country.

Keywords: *Beads, Glass, Manufacturing, Chemic Composition, Glaze, Banaras Beads Limited, Lamp Winding and Furnace Winding.*

Date of Submission: 14-10-2024 Date of acceptance: 30-10-2024

I. Introduction:

Beads function as a form of human expression. Horace first presented a structured perspective for studying beads, stating that "to fully describe a bead, it is essential to outline its form, perforation, colour, material, and ornamentation" (Beck; 1928). Sleen linked manufacturing techniques to the study of beads (1973). Dublin advanced the study of beads in 1987, asserting that "beads reflect the culture they are part of, highlighting the social, political, economic, and cultural facts of the related culture".

History of Glass in Ancient Civilizations:

Glass is a state of matter that is primarily composed of silica and is made at very high temperatures, hence referred to as a "super cooled liquid". While glass and glaze are chemically similar, they differ significantly in their function and use. The phenomenon of glazing was first associated with the production of glass or synthetic glass materials through the glazing technique (Barthelemy; 1994). Extensive use of glaze is documented in the third millennium BCE in the Indus Valley Civilization. Glass is often applied as a coating on an object's core or base, giving it a shiny and attractive appearance with desirable properties. The technique of applying this coating is visible both before and after firing in the kiln, depending on various contexts. In the fourth millennium BCE, the technique of glazing and glass coating can be traced to the Bactria, Mesopotamian, and the Indus Valley civilizations. Glass can generally be divided into two categories: Oxide-based glass and non-oxide-based glass, sulphide-based glass is primarily used for commercial purposes.

Bharadwaj (1987) and Dr. Singh (1989) argued, based on the shiny pottery shards, that the Harappans were familiar with glass production techniques. However, due to the lack of accurately dated references, it could not be ascertained that the Harappans had mastered the art of glass production (Singh 1989). It is possible that "glass could have been manipulated to the point where it began to resemble faience" (Singh), hinting at the possibility that some glass beads were misclassified as faience beads, and the Harappan civilization was not credited with glass production. Evidence of extensive use of post-Harappan-PG Wares in Bhagawanpura, Haryana, is found, which dates back to approximately 1400-1200 BCE. A thorough examination of objects

obtained from bronze-casting sites is necessary because they provide information on a large quantity of vitrified stibnite, which is shiny. It is important to mention here that some beads that were interpreted as shell beads (Wheeler, Castle, and others; 1946, 1949) have now been identified as glass beads (Francis).

In literary and archaeological sources, the mention of glass beads can be traced back to ancient times in the Indian subcontinent. References to glass beads can be found in the Yajurveda (1200 BCE), where they are mentioned as being worn by women along with golden threads. The Shatapatha Brahmana (1000 BCE) mentions the use of glass beads during the Ashvamedha Yagna to adorn horses. References to glass beads can also be found in the Taittiriya Brahmana and the Sutra period (Baudhayana Shrauta Sutra and Manusmriti). Similarly, the Ramayana and Mahabharata also contain words related to glass beads. The Arthashastra of Kautilya describes the methods of glass manufacturing, along with penalties of 46-96 panas for stealing copper, brass, tin, ivory, and glass items. The Vinayapitaka of the Buddhist period instructs to avoid objects adorned with glass beads. The Puranas (Matsya, Bhagavata, and Vishnu) also mention glass beads. Pliny commented in his "Natural History" that Indian glass was of high quality because it was not made from sand but from crushed silica crystals. This is confirmed by Stern (1987), who stated that until recently, government glass factories in India were producing glass by crushing silica crystals. It is known from Periplus that glass and glass-made objects were exported to other countries.

From the first millennium BCE to the 19th century, glass objects were obtained from excavations of Indian archaeological sites. The earliest discovery of glass beads from the Bhagwanpura site, overlapping with the late Harappa period, is noted by Joshi (1993). Confirmation of glass beads from the second phase of Navdatoli is found in Dev (1995). While only a few sites of the OCP culture yielded beads, the production of glass started on a wider scale from the PGW phase, as noted by Niharika (1993). During the Maurya and Shunga periods, all types of glass beads were particularly distinctive, with mentions of acquiring beads from places like Kaushambi, Ahichchhatra, Rajghat, and Patna. In the Satavahana period, high-quality beads were found in Nasik, Karad, Kolhapur, Maski, Chandravalli, and Kondapur. In the 1st century CE, glass beads were obtained from places like Nevasa, Taxila, and Arikamedu, among others.

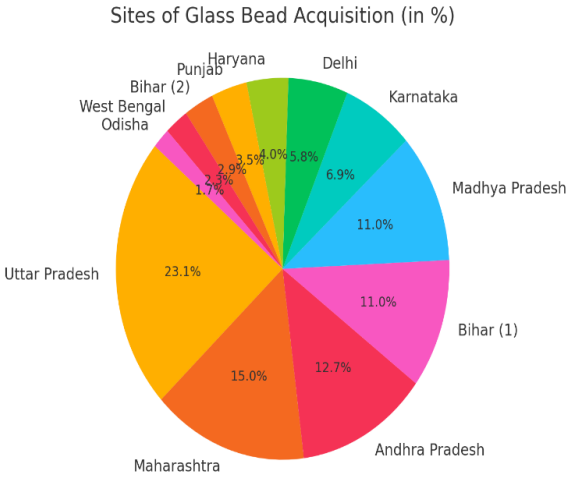
Glass beads from earlty historic Nevasa and Glass bead production debitage from Arikamedu

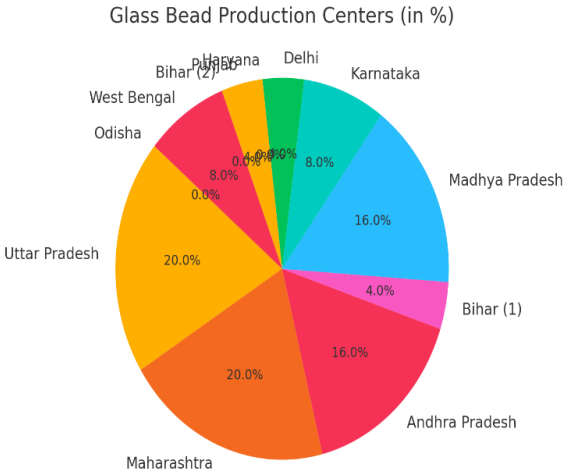
Chemical analysis of approximately eighteen regions (such as Ahichchhatra, Taxila, Kaushambi, Kolhapur, Kopiya, Kurukshetra, Nalanda, Tripuri, and Rajghat, among others) indicates that Indian craftsmen were well acquainted with raw materials and colouring agents for glass making. Analysis of glass beads from Taxila and Tripuri revealed the presence of lead oxide and barium oxide, respectively. Francis (1985-1994) demonstrated through the analysis of glass beads from Arikamedu that the presence of potassium indicates they were made from local glass.

Excavations and analysis of various archaeological sites have confirmed the presence of glass beads from more than two hundred sites, with evidence from 150 sites confirming the presence of glass beads and 32 sites identified as glass production centres.

State	Sites of Glass Bead Acquisition	Glass Bead Production Centers
Uttar Pradesh	40	5
Maharashtra	26	5
Andhra Pradesh	22	4
Bihar	19	1
Madhya Pradesh	19	4
Karnataka	12	2

Delhi	10	1
Haryana	7	-
Punjab	6	1
Bihar	5	-
West Bengal	4	2
Odisha	3	-





Glass beads were manufactured in ancient India using materials like silica sand, quartz, and alkali obtained from various sources. These included reh clay (clay) and soda from the salt lakes of Didwana and Lonar in Rajasthan, as well as from plants in Ahmadabad, Gujarat. Indian artisans also used copper, manganese, tin, antimony, and iron as colorants. Manganese and cobalt were used for pink and blue colours respectively, and with the development of chemistry, various other colours were produced. It is likely that locally produced low-grade soda was used for glass production in India. According to Francis, both imported and indigenous glass were used for bead making in India. Scientific analysis of some glass samples supports this view. Unlike glass from Egypt and the Roman Empire, which contained soda as sodium oxide, glass from Arikamedu in India and Oc-Eo in Vietnam clearly shows the use of sodium and potassium oxides.

Time Period	**Sites (Evidence of beads)**
1200 – 600 B.C.	Alamgirpur, Amahata, Atranjikhera, Autha, Bagor, Banahalli, Bhagwanpura, Brass, Daulatpur, Hastinapur, Jakhera, Jhatikra, Kodumanal, Kotra, Kunnattur, Manikpur, Maski, Munahi, Nagiari, Narhan, Pairyampalli, Pallavamedu, Pasewa, Runija, Sanghol, Sarhat, Shirkanda, Sravasti, T-Kallupatti
600 – 300 B.C.	Alagankulam, Amethi, Ayodhya, Benagutti, Champa, Danwa, Daulatpur, Dharanikota, Dhatva, Ganwaria and Salargarh, Gauriganj, Harnol, Hastinapur, Hulas, Jajmau, Jakhera, Kadipur, Kheradih, Kopia, Kotra, Malvan, Mathura, Munahi, Nadner, Narhan, Noh, Paunar, Prahaladpur, Prakash, Rajghat, Singh Bhagwanpur, Sonepur, Sravasti, Sugh, Tumain, Vaisali
300 B.C. –400 A.D.	Adam, Adamgarh, Adiyamankottai, Agroha, Ahichchhatra, Alagankulam, Alagarai, Appukalu, Arikamedu, Arni, Aunhan, Ayodhya, Bagor, Balathal, Banahalli, Banavasi, Basarh, Besnagar, Bhita, Bhokardan, Brahmagiri, Brass, Broach, Chandahadih, Chandraketugarh, Chandravalli, Chechar, Chirand, Daulatpur, Devnimori, Dharanikota, Dhatva, Dhulikatta, Dhuriapur, Eran, Erich, Ganwaria and Salargarh, Garapadu, Hari-narayanpur, Hastinapur, Hemmige, Hulas Khera, Irla, Jhatkira, Jhusi, Kakrethta, Kanchipuram, Karad, Karaikadu, Karur, Kausambi, Khairwada, Khangabok, Khartuni, Kheradih, Kohir, Kolhua, Kondapur, Kotalinga, Kudikadu, Kumrahar, Kusan, Maheshwar, Malhar, Mangalkot, Manjhi, Mansar, Masaon, Maski, Matin-Mahadev, Nadner, Nagara, Nagarjunakonda, Narhan, Nasik-Jorwe, Nattamedu, Nelakondapalli, Nevasa, Noh, Orai, Paithan, Pandigadda, Pataliputra, Paunar, Pauni, Peddabankur, Perur, Piklihal, Prakash, Puduru, Pydigutta, Raiah, Rajbadidanga, Rajghat, Ratura, Sanghol, Sankisa, Sannati, Satanikota,

	Satara, Singh Bhagwanpur, Sisupalgarh, Sonkh, Sravasti, Sringaverapura, Srisailum, Sugh, Sultanpur, Taradih, Taxila, Ter, Tharsa, Tilwara, Tirukkambuliyur, Tripuri, Tumain, Ujjain, Vadagaon-Madhavapur, Vadnagar, Vaisali, Virpur, Yeleswaram
400 – 1300 A.D.	Adiyamankottai, Ahichchhatra, Alagankulam, Ambari, Anantapur, Apsad, Arambha, Atranjikhera, Banavasi, Basarh, Benagutti, Bharat Mandir, Bhita, Bhokardan, Buxar, Champa, Chechar, Daulatabad, Dhuriapur, Dwarka, Eran, Fatehpur Sikri, Gilaulikhera, Gudnaput, Harsh–ka-tila, Hastinapur, Hulas Khera, Indragarh, Jokha, Kambarmedu, Kanchipuram, Kanheri, Karnachaura, Kashipur, Katpalon, Khairwada, Kolhua, Kumrahar, Kundavelli, Maheshwar, Malhar, Mangalkot, Mansar, Masaon, Maski, Nagarjunakonda, Nagnoor, Nalanda, Narhan, Pallavamedu, Pandigadda, Paunar, Perur, Prakash, Ratnagiri, Sanjan, Shamalaji, Singh Bhagwanpur, Sirpur, Sohgaura, Sonkh, Sringaverapura, Taradih, Taxila, Tharsa, Tirukkambuliyur, Tripuri, Tumain, Ujjain, Uraiyur, Vadavur, Vaisali
1300 – 1800 A.D.	Alampur, Ambari, Antichak, Bahal, Batesvara, Bijai Mandal, Brahmapuri, Buxar, Chagatpur, Chandoli, Chermanparambu, Daulatabad, Dwarka, Eran, Fatehpur Sikri, Golconda, Hampi, Harsh – ka - tila, Hemmige, Jhatkira, Kadipur, Kadkal, Kanchipuram, Karvan, Kaundanpur, Khairwada, Khalkata-patana, Kundavelli, Lalkot, Maheshwar, Makhdum Sahib's Mosque, Matin-Mahadev, Nagiari, Naksaparvat, Nasik-Jorwe, Navdatoli, Nevasa, Pachkheri, Padavedu, Pataliputra, Paunar, Purana Qila, Raisen fort, Rajghat, Salimgarh Fort, Singh Bhagwanpur, Sirpur, Sohgaura, Tiruverkadu, Uraiyur

The Evolution of Glass Bead Production from Ancient to Modern Techniques:

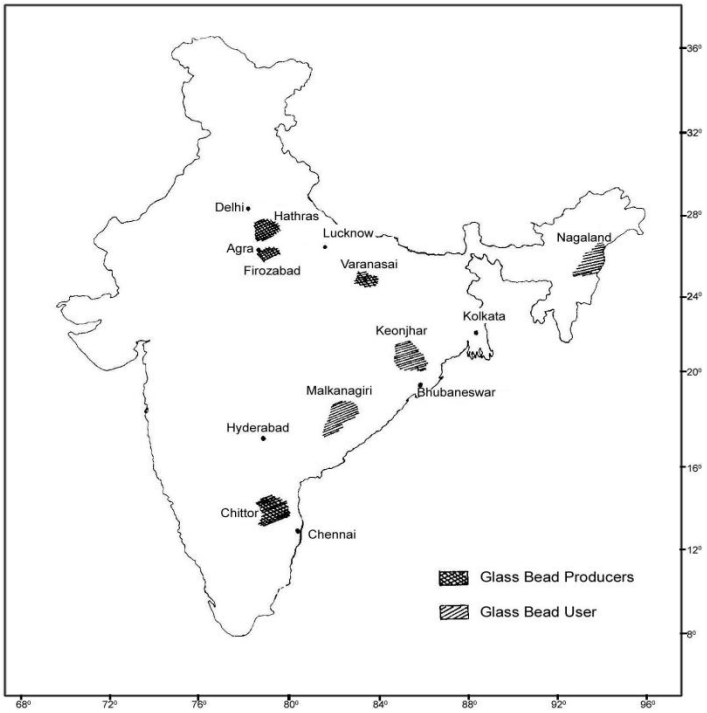
Glass beads involved combining silica and alkali, such as soda or potash, and heating them together at moderate temperatures to solidify them. Since the melting point of silica was low for ancient furnaces, alkali was added to lower it. Additionally, lime (CaO) or other stabilizers were also added, although ancient producers may not have been aware that lime is inherently impure when mixed with sand (Turner, 1956). These ingredients were heated for several days to create a hardened mass known as "frit." In the next stage, the "frit" was crushed to obtain a fine powder for mixing. In the final stage, the powder was fully melted and the beads were shaped, polished, and cut. Technically, heating raw glass above its melting point and converting it into beads without crystallizing it required expertise.

There are several ways to create glass beads from a piece of glass. Since ancient times, artisans in the glass industry have experimented with various imaginative techniques to produce beads, leading to the development of advanced techniques in modern times, such as spinning, dipping, drying, mould pressing, cutting, grinding, and drilling.

In the Indian subcontinent, most beads found at archaeological sites were produced using drawing or winding and moulding techniques. Bead-making involved three of the oldest and most important techniques, which are still in use today. In contemporary times, it is necessary to classify glass beads based on their manufacturing techniques, and studying their production alongside related cultural materials would be beneficial (Kanungo; 2000-01).

The bead-making process requires a division of labour and specialization across various stages, and it is not suitable to leave all the stages to a single artisan. For example, tasks such as material procurement, shaping, cutting, and polishing should be divided. From an ethnographic perspective, there are currently three major bead-making industries in India that use traditional techniques for producing and exporting beads.

1. Purdalpur, Uttar Pradesh
2. Varanasi, Uttar Pradesh
3. Papanaidupet, Andhra Pradesh



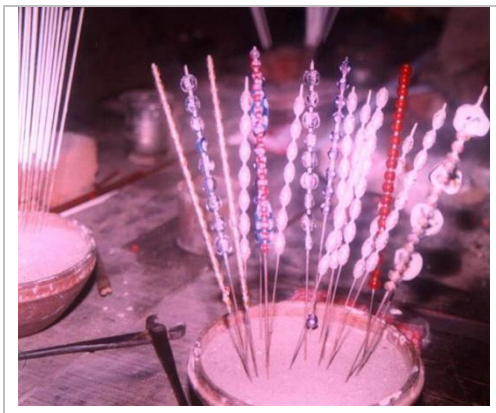
4. (Kanungo, 2004, BAR International Series 1242, Ethnographical Field Area)

There are three types of bead making techniques-

Winding Technique: Glass is a supercooled liquid, with silica as its major ingredient, requiring a very high temperature to melt. It cools and hardens rapidly, leaving craftsmen a brief window to shape it. Despite this, beads have been artistically shaped from glass since ancient times. The winding and moulding techniques have been crucial for designing and shaping beads, recognized as the oldest, simplest, and most common methods of bead-making (Sleen 1973:23; Francis 1992:15; Basa 1993:93).

In India, the most enduring glass bead production technique is the winding method. In this process, glass is twisted around a metal rod or wire to produce beads, known as wound beads. Often, different moulds are used to create various shapes for the beads.

Lamp Winding: Glass is transformed into rods or sticks called canes, which are melted using a small heat source, traditionally a lamp. The molten glass is then wound around a thin wire or mandrel, and while still hot, the bead can be shaped or decorated with other colored glass canes, with the process controlled by the lamp flame. These beads are annealed in the flame, and once cooled, they are removed. This traditional bead-making technique is used in various parts of the world, including Italy, Indonesia, France, China, the USA, and Germany (Francis 1992:15).

	
Wound beads on rods, Polis	Polishing of beads

Furnace Winding: Furnace winding involves heating glass in a crucible within a furnace. An iron rod, known as a mandrel, is dipped into the molten glass and twisted quickly as it is pulled out, forming the glass bead. While still hot, the bead can be shaped with paddles and other tools, and additional glass can be added for decoration. Ethnographically, this technique is used to produce beads in many regions around the world, including China, the Middle East, Turkey, Egypt, Uzbekistan, Afghanistan, and Nigeria (Francis 1992:15).

These beads share some similarities in their production, such as the use of glass tubes and a process involving dipping or covering the tubes for protection and appearance. However, they differ in the materials used for foiling (gold foil vs. silver nitrate solution), the final appearance (gold-like vs. silvered), and historical origins.

Banaras Beads Limited [Varanasi]

Other beads making techniques (In table charts)	
Bead Making Technique	**Description**
Folded Beads	Made from flattened glass rods folded around a wire and shaped by rotating. The seam where the ends were melted together is often visible, running parallel to the perforation. This technique is observed in specimens from Bhokardan, Brahmapuri, and Kondapur.
Pressed Beads	Formed when beads are partially molten and can be easily pressed into various shapes such as hexagons, squares, bicones, or barrels with flattened ends.
Coiling	Two types: ring coiling and spiral coiling. Variations of the winding method where glass is heated and allowed to flow onto a horizontally suspended wire.
Hand-Perforated	Created by dropping small ferrules of semi-molten glass on an earthen platter and then piercing them with a pointed spoke or hot iron nail while still plastic. This process leaves a burred edge on the lateral end of the bead and is described in the Arthasastra.
Bored Beads	Have perforations made from one side or both sides, with the perforations meeting at an angle in the case of double-side boring.
Double Strip Method	Involves fusing together two flat strips of glass with a metal wire in between for the perforation. A common and popular technique.
Twisted Beads	Made by taking a small lump of molten glass on a thin wire and rotating it briskly until it acquires the requisite shape. Annular and spherical beads are made using this technique.

Aspect	**Gold-Foil Beads**	**Silver-Plated Beads**
Main Material	Transparent glass tubes	Glass tubes, often amber-colored for gold appearance
Foiling Process	Gold foil applied to sections of tube	Silver nitrate solution sucked into tubes
Dipping Process	Tubes dipped into molten glass for protection	Silver covers inside of glass
Appearance	Brilliant, shiny	Can mimic gold appearance with amber-colored tubes
Other Colors	Blue, green, and black beads also made	Blue, green, and black beads made, with or without silvering
Additional Treatment	Tubes pinched to form segments, sometimes fire-polished	Long tube broken into single beads, placed on string
Historical Significance	Associated with advanced technology and skill in ancient India	Utilized a process known from early periods, ancient Egypt also considered origin
Notable References	Dikshit, Singh, Francis	Arthashastra

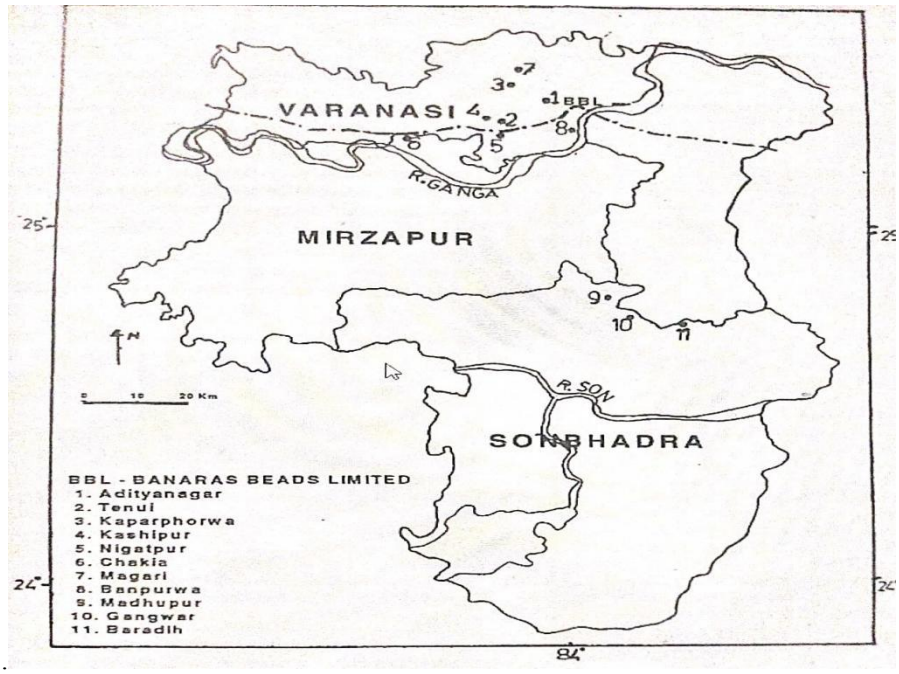
Banaras Beads Limited (BBL) was founded in 1940 with the assistance of a Czech couple by Kanhaiya Lal Gupta. Initially, BBL manufactured its cane beads near Assi in Varanasi at the Assi Banaras Glass Works until 1960. The company initially produced its glass canes independently but currently imports them from Firozabad. Artisans at BBL work on wooden stools equipped with a blow lamp, with a pair of bellows below to stabilize the flame at chest height and direct it to a point. They wear tin covers for eye protection and visibility.

About 7-8 artisans work at each table, with one operating the bellows to supply air to the lamp through three to seven air pipes, maintaining the high temperature needed for melting glass. An artisan picks up a rod, dips it into kaolin (porcelain clay), and wraps the hot glass around it. The beads are shaped using chipping and carving techniques by pressing the glass against the mandrel to achieve the desired shape. Afterward, the finished beads are cleaned using kaolin or porcelain clay with the help of rural women before being exported. This center is the leading industry in 11 villages across Varanasi, Mirzapur, and Sonbhadra districts of Uttar Pradesh. BBL exports more than 50,000 types of beads to over 80 countries worldwide, including Japan, China, the Philippines, Hong Kong, Thailand, Lebanon, Saudi Arabia, Australia, South Africa, and Canada, with 50% of its exports going to the United States.

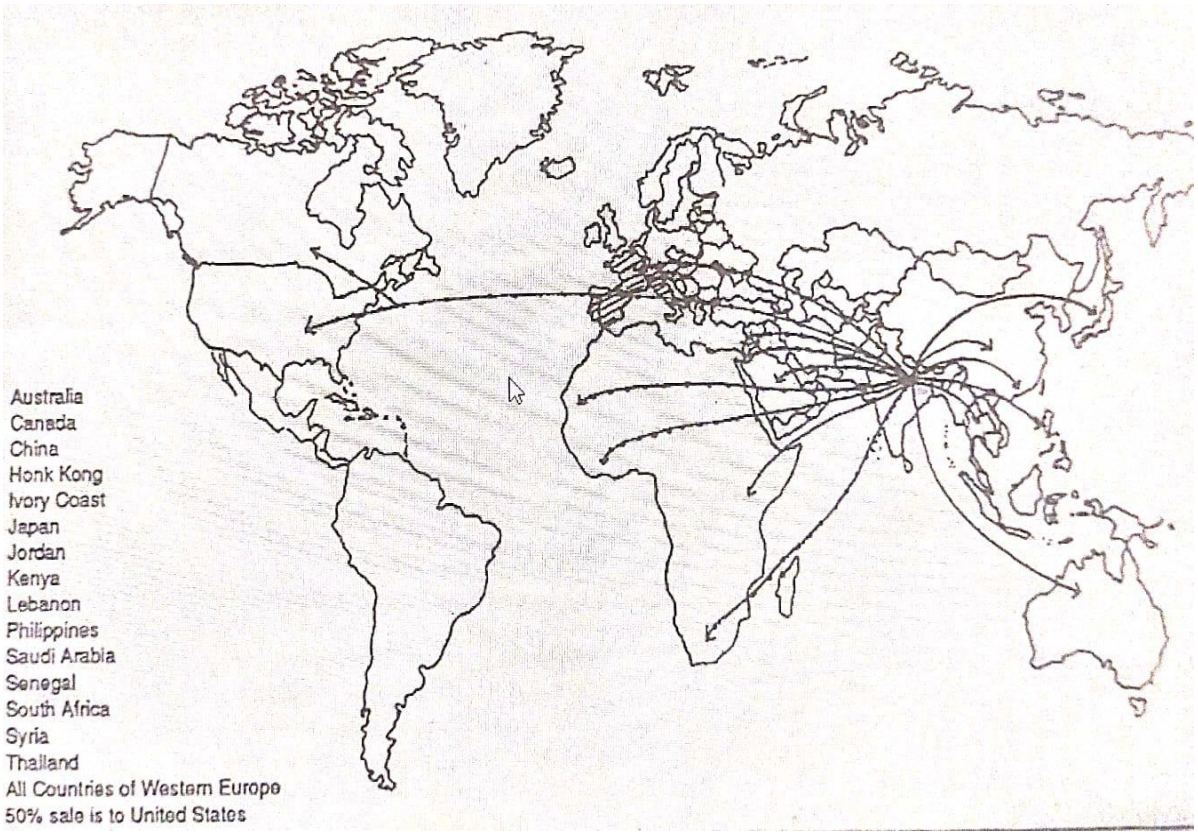
Due to the relative security of sea trading and limited land routes, coastal sites were crucial in trading activities for exporters like BBL. Currently, while BBL handles major trading, the actual production occurs in villages around Purdalpur and Varanasi within a 250 km radius. Therefore, BBL likely has little to no manufacturing debris compared to the surrounding village centers. In contrast, villages will almost entirely lack finished products, as these are sent to BBL for export.

At Banaras Beads Limited, three primary techniques are used for bead production. Firstly, simple wound beads are made by wrapping coloured glass canes around a mandrel, which a master craftsman shapes by twirling the mandrel with the hot glass. Secondly, appliqué beads are created by applying different coloured glass canes to form designs on the hot wound beads. Lastly, mould beads are formed by winding glass around a rod and using a press tongue mould to shape the hot glass into various forms.

Self-assessment and observations of BBL Varanasi. 2023



The production of beads for Banaras Beads Limited takes place in villages, Kanungo, Glass Beads in India: lamp Winding and Moulding Techniques, Man and Environment, Vol 26,2001



Global export of BBL beads, Kanungo, glass beads in India: lamp winding and moulding techniques, Man and Environment, Vol 26,2001

In general, to create glass beads, artisans utilize glass rods and add decorative elements such as flowers, dots, lines, and curves. The glass is heated using a flame, and a metal rod coated with chalk is rotated, preventing the beads from sticking and ensuring a smooth, even surface. Designs are added based on the desired pattern, and colours are meticulously chosen. Gold and silver foils are used to craft intricate canes and foil beads, requiring significant skill as the foil is wrapped around a metal stick and encased in transparent molten glass. Techniques

like millefiori, where small glass pieces are embedded into a core to form beads, are popular. Crystal beads are created from flat glass sheets, dyed, and then coated with a layer of water glass to achieve a translucent appearance. Various styles are used, including silver foil rosaries and vibrant opaque designs (Bhatt, 2016).

The taper bead is tested for consistency, strength, and hardness, and beads can be cut, faceted, and shaped to meet specific customer requirements. Each bead is handmade, making them unique despite their similarities. The main types of glass beads produced in Varanasi include single-color crystal, transparent, opaque, animal-shaped, dotted, variegated, millefiori, and cashmere beads. Varanasi beads were awarded a GI tag in 2016.

Glass beads were highly valued in Africa due to their association with advanced technology. They played a significant role in African communities, intertwined with various aspects of society, including beautification, age, kinship, marital status, hunting, commerce, rank, rituals, and religious beliefs. In the grasslands of Cameroon, ceremonial chairs are completely covered with beadwork. Beads also marked significant stages in a woman's life. For instance, reaching puberty was a celebrated occasion, signaling a girl's readiness for her roles as a wife and mother. Among the Iraqw of Tanzania, maidens in seclusion during menstruation made beaded leather back skirts, showcasing some of the most spectacular beadwork from Eastern Africa. The Zulu love tokens, found in KwaZulu-Natal and the Eastern Province of Africa, are well-known examples where beads served as a form of communication. The symbolism in these tokens lies in the colors and their sequences, with specific colours carrying particular meanings that, when assembled in a sequence, convey messages.

Thus, glass beads hold cultural and artistic significance in both Varanasi and various African communities. In Varanasi, they are celebrated for their craftsmanship and variety, while in Africa, they are deeply woven into the social and cultural fabric, symbolizing different aspects of life and communication (Bhatt, 2016).

The Timeline of Glass Beads: In the latter half of the first millennium AD, glass objects were produced on a large scale. The process of shaping glass in furnaces was fully understood and utilized by artisans of that time. In ancient India, glass beads were being produced using indigenous techniques on a large scale in various places in the second millennium AD.

Archaeological Site (Bead's finding)	**Period**
Atiranjikhera	1200 BCE - 600 BCE
Hastinapur	1100 BCE - 800 BCE
Maski	800 BCE
Arikamedu	300 BCE
Nevasa	700 CE
Taxila	600 BCE

III. Conclusion:

The inherent human inclination towards beauty and attraction has always led them to be continuously innovative, pioneering, and artistic. In Indian society, the significance of glass beads has remained equal for both the affluent and the poor. Glass beads are not merely objects of decoration but have been an important medium to highlight various aspects such as cultural, historical, social values, personal wealth, medicinal treatment, symbolic representation, and technological development. To understand the continuity of glass beads and their manufacturing techniques, it is necessary to study the evidence of anthropology and genetics in the absence of archaeological evidence. The fashion of glass beads made using the winding technique, brought into use by urban society, existed in tribal society since ancient times. Therefore, the sequential development of techniques from ancient times to the present can be understood by studying the technologies of Indian indigenous tribes. The enduring tradition of Indian glass bead production reflects the country's vibrant heritage and intricate craftsmanship. The study not only illuminates the historical and technical aspects of this craft but also celebrates its role in perpetuating India's rich cultural legacy through the ages.

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