

AN ARCHAEOLOGICAL HISTORY OF ROMAN GLASS

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Abstract

Glass, in its natural form, has been used since the Stone Age, but it wasn't until about 3000 B.C., after the Phoenicians inadvertently "discovered" glass, that glassmaking techniques were developed and manufactured glass became an important part of human culture. In ancient times, people were conscious both of its utility and of its beauty. It was the Romans, however, who refined the art of glass working, adding to its utilization. Their established trade networks ensured its trafficking throughout Europe, Asia, and Africa. Several archaeological sites, as discussed in this paper, hold clues as to how glass was made and why it was so widely used and, in the beginning of its production, so highly prized.

Introduction

Since the beginning of their discovery and invention, both natural and manufactured glasses have become an integral part of our culture. W.B. Honey believes that, “Glass nowadays is too familiar to arouse all the wonder it deserves” (MacFarlane 2002). In the past, people were aware of its beauty as well as its utility. Natural glass is formed when certain types of rocks melt as a result of high-temperature events, such as volcanic eruptions, lightning strikes, or the impact of meteorites. The rock then cools quickly and solidifies. Natural glasses include obsidian, which is a natural glass made from the lava of a volcanic eruption, and tektites, which are naturally formed extraterrestrial glass (Glass Online 2007).

Though the Phoenicians originally discovered glass, the Romans were the people who made it into the art it is today. Their glass working techniques advanced the practice to make glass a prized possession, originally available only to high ranking officials. Eventually, as glass spread across the well-defined Roman trade routes, glassmaking and working techniques expanded throughout the Roman Empire. Various items became more readily available to the general public. Glass was used more frequently and more commonly. Though the original glass stock has only been found at two known sites in the Roman Empire, Beit She’arim and Beit Eliezer, both in Israel, it was worked and refined into vessels and other articles at numerous sites throughout the Empire (Fleming 1997).

This paper seeks to discuss the spread of Roman glass, as well as glassmaking and working technologies throughout the Roman Empire and the rest of the known world at that time (1st century B.C. - 7th century A.D.). It also discusses two of the only known sites of Roman glassmaking and describes the different types of glass produced by the

Romans. These topics are imperative to learning about glass and the Roman Empire, as both played an integral part in the forming of each other's histories.

Methodology

The methodology used in this paper includes extensive research from books, journal articles, websites, and physical glass artifacts. I have researched the history of glassmaking, the history of the Roman Empire, the original formula for glassmaking and the methods used to make it, the spread of glass and glassmaking technology throughout the world at that time, several sites where glassmaking and working had taken place throughout the empire, and the many different types of Roman glass. I have completed two shorter, more concise research papers concerning Roman glass and glass in general. I applied my acquired knowledge and references from those papers to this one. I have also visited the Corning Museum of Glass's Rakow Research Library in Corning, NY. There I viewed their broad collection of Roman glass and utilized their extensive library of glass-related books and articles.

Pre-Roman Glass

In the 7th century A.D., Isidore of Seville wrote that Phoenician traders transporting stone actually "discovered" glass in Syria. He states,

The origin of glass is as follows. In Phoenicia, an area of Syria near Judaea, is a swamp at the foot of Mt. Carmel where the river Belus arises...The rushing stream washes any filth from its sand. Tradition says that a ship of natron merchants was driven aground here. Here and there,

on the shore, they were preparing dinner. With no stones for raising up the cooking vessels, they used hunks of natron from the ship. Shore sand mixed with it as it burned and translucent streams of a new liquid flowed forth. This was the origin of glass (Isidore of Seville 2005).

In the third millennium B.C., central Mesopotamian craftsmen were using the basic raw materials of glass to glaze pots. When calciferous sand somehow got into a kiln, combining with soda, it formed a glaze on the ceramics. Actual glass production began around 2500 B.C. with the manufacture of beads, seals, and architectural decoration. Glass vessels were not constructed until about 1000 years later. (Glass Online 2007).

Ancient glass is a mixture of approximately 72% silica, 15% soda, and 10% lime, with natural impurities making up the final 3% (University of Pennsylvania Museum 2007). Quartz, feldspar, and calcium-rich shell material, the compilation of which makes up beach sand, are the source of the silica and lime used. Natron, a complex carbonate compound, was usually used to fill the soda requirement. The ingredients are heated to 800 degrees Celsius in a wood-burning furnace in order to properly fuse. Pieces of this mass, called "frit," would then be broken off and either heated to 1100 degrees Celsius until it was completely melted, or crushed and used to color other glass combinations. Reusing a piece of glass made in this way required heating the glass to a temperature of only 750 degrees Celsius (Fleming 1997).

In the beginning, glass was mainly used for beads and other small ornaments, and was probably an accidental by-product of slag, the waste product of metallurgy. Eventually, tiny, translucent or opaque colored pieces were used as inlay, providing the

look of precious stones. An example of such inlay work is found on the famous sarcophagus of King Tutankhamen (Fig. 1), the surface of which is inlaid with blue, turquoise, and red glass (Beyer and Kämpfer 1966).

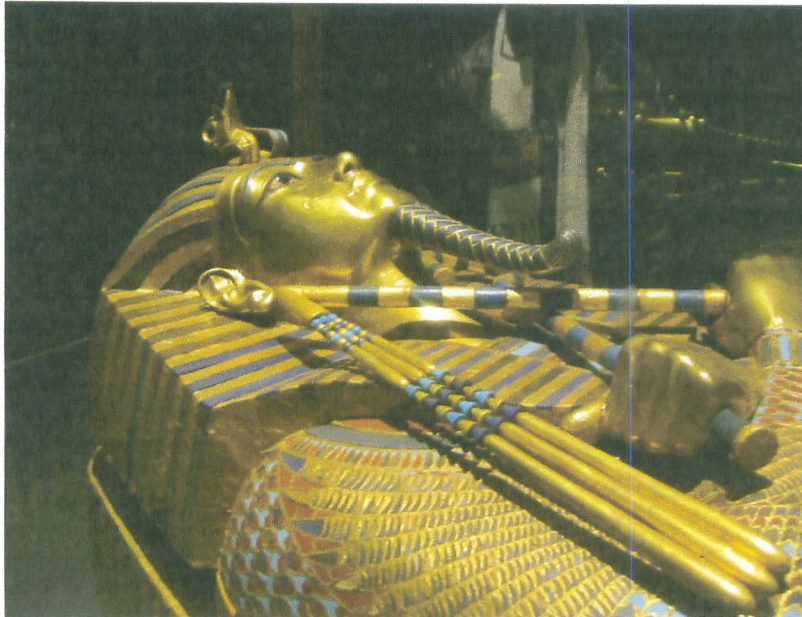


Fig. 1: King Tutankhamen's glass-inlaid sarcophagus at the Egyptian Museum (Photo: Spier 2005)

Glassmaking began to spread from western Asia towards the eastern and central Mediterranean in the 7th and 6th centuries B.C., with Alexandria, Egypt becoming a huge center of glass production, as well as Syria, Israel, and the island of Rhodes (Whitehouse 1988).

The oldest evidence of hollow glass production is from the 16th century B.C. in Mesopotamia where pieces of glass vases have been found (Glass Online 2007). By 1500 B.C., small, colorful vessels were being produced in Mesopotamia and Egypt. Canes of molten glass were wound around a core that was later removed, producing a mosaic-looking effect. The vessel was then heated until the canes were fused (Whitehouse 1988). After 1500 B.C., Egyptian craftsmen began developing a method for producing glass pots

by dipping a mold of compacted sand into molten glass and then turning the mold so that the molten glass could adhere to it. While still soft, the glass-covered mold could then be rolled on a stone in order to smooth or decorate it (Glass Online 2007).

It was in Egypt and Western Asia, during the Late Bronze Age, that glassmaking technology really began to take off. Blue glass, colored with cobalt, became popular, as did imitating non-glass vessels and other items with glass. By the 15th century B.C., extensive glass production was occurring in these areas. The techniques required for the initial formula of glass from raw materials was a well-kept secret, only shared with those of the larger palace industries. Glass workers in other areas were forced to work with imported, pre-made glass (Glass Online 2007). In Mesopotamia in the 8th century B.C., larger, open vessels began to be produced using molds. These were normally monochrome in color, usually greenish or amber, the natural color of glass (Whitehouse 1988).

In the early stages of glassmaking, craftsmen used an older method of forming glass, casting it in pre-made “blank” molds. Molten glass was kept in a liquid state at about 550 degrees Celsius using a wood-burning furnace. The most common method used for most of the open-form cups and bowls in the first century B.C. was the technique of draping glass over a convex “former” mold (Trentinella 2003).

During the Hellenistic Period (3rd-1st centuries BC), a number of new techniques were introduced and glass was used to make larger pieces, particularly tableware. Molds and mosaic glassware were popular styles. Colorless glass also became popular and people developed new methods for achieving this effect. The spread of glassblowing technology revolutionized the glass industry. The long, thin metal tube used in the

glassblowing process is almost identical to the tool used today (Glass Online 2007). It paved the way for the sudden increase in glass production that soon occurred throughout the Roman Empire.

The Roman Empire

History

The Roman Empire is often marked as officially beginning with the appointment of Julius Caesar as *Dictator Perpetuus*, or “dictator for life,” in 44 B.C., though some claim it should be marked by the victory of Caesar's heir, Octavian, at the Battle of Actium in 31 B.C., or when the Roman Senate granted to Octavian the title *Augustus* in 27 B.C. (Dupont 1992). Although the actual city of Rome is thought to have begun sometime around 625 B.C., and they had conquered most of Italy by 260 B.C., this was nowhere near the expanse of the empire that it was about to become. The earliest date that anyone might consider Rome to have an empire would be 201 B.C., after the Roman victory in the second Punic War. From the time of Augustus to the fall of the Western Empire, the Roman Empire included England and Wales, most of Europe west of the Rhine and south of the Alps, coastal northern Africa, the Balkans, the Black Sea, and Asia Minor, as well as much of the Levant (Fig. 2) (Wacher 1987). Most of the people living in these areas considered themselves Romans and followed the Roman laws.

Rome, being the capital of the Empire, was naturally the center of all trade. Originally a small settlement on the Palatine Hill, it grew to be the greatest city in the ancient world. Like politics and trade, the industry of the Roman Empire also centered on the city of Rome. As the Empire expanded, the demand for luxury items and large public

works also expanded. However, Rome's imports vastly exceeded its exports, with the exception of bronze goods, as it was more a city of consumption than production. Within the city, foreign craftsmen worked mainly with precious metals, as well as glass, to create masterpieces of luxury (Wacher 1987). The city of Rome itself was not a major producer of glass until the 1st century A.D. (Whitehouse 1988).

Between 235 and 284 A.D., the Empire went through a near-collapse that was attributed to a "military anarchy." There was an almost constant flood of barbarian invasion, hyperinflation, and civil war. Augustus had neglected to establish rules for the succeeding monarchs and the result was a struggle for power, with twenty-five different emperors ruling Rome during this period. In the end, lack of citizen support in local administration forced the emperors to resume responsibility as a working government (Wacher 1987).

In 284 A.D., the emperor Diocletian split the Empire into two parts along a northwest axis, just east of Italy. He named himself Augustus of the Eastern Roman Empire and his friend, Maximian, Augustus of the Western Roman Empire. In 293, each *Augustus* took on a junior Emperor with the title of *Caesar*, forming a Tetrarchy, or "leadership of four." It was decided that, upon the death or abdication of the *Augustus*, the *Caesar* would replace him and, in turn, select a new *Caesar* (Dupont 1992).

The end of the Western Roman Empire is often considered to be September 4, 476 A.D., the day Romulus Augustus, the last emperor of the Western Roman Empire was overthrown. The Western Roman Empire had steadily declined throughout the course of the 5th century. The Eastern Roman Empire, now known as the Byzantine

Empire, kept its Greco-Roman culture and Christian religious components until it eventually fell to the Ottoman Empire in 1453 (Kamm 1995).



Fig. 2: The Roman Empire at its greatest extent, 117 AD (Image: Jani Niemenmaa 2004)

The Romans and Glass

Beginning in the mid-1st century B.C., the Romans dominated the glassmaking industry (Fleming 1997). Because of their major land conquests, trade routes, and roads, the Romans created a highly effective means of transport for glass products and technology. Glass has been located throughout Germany, Switzerland, Italy, France, and

even China by way of the silk routes dating to the time of the first Roman emperor's reign (Glass Online 2007). Many new techniques were also introduced during this period. Roman glassworkers were inspired by historical events and technical innovations, as well as current fashions and trends. There was always a war or new government policy that manipulated the industry and many craftsmen worked outside the original standards of their trade (Fleming 1999).

Up until this point, glass was a very valuable commodity, available only in small amounts and to the extremely wealthy. In the Bible, the book of Job compares glass to gold (Job 28:17). However, with the invention of glassblowing, it became a material readily accessible to the general public. In fact, glass became so cheap that by the 2nd century A.D. the Latin term *vitrea fracta*, which means "broken glass," became synonymous with the Latin word for "rubbish." Then, glass was traded less as a commodity and more by the value of its contents. Liter-sized jars and bottles were used to transport items such as preserved fruits, wine, oil, and perfume (Fleming 1997). Unlike ceramic or metal vessels, glass bottles did not alter the scent of the perfume, wine, or food they held, making them much more desirable containers (Charleston 1980). The most popular colors used in glassmaking were translucent blue, translucent green, opaque red, and opaque white (Whitehouse 1988). Glass began being used for tableware and window glass, both made mainly of an unpurified, greenish or yellowish glass (Charleston 1980).

The Romans began to make objects such as hairpins, game pieces, glass beads, rings, mirrors, magnifying glasses and statues (Whitehouse 1988). There was even glass that was said to be "unbreakable" (Pliny 1890). Though some of these objects,

particularly beads, had been made in the past, the Roman techniques used provided craftsmen with various design prospects and thus added to the expense and rarity of the finished product.

There are several Roman glassworkers who are still known today because their names had been added to their glass pieces. Probably the most famous was a craftsman named Ennion, who is believed to have been from Syria, but may have either migrated to or opened a branch factory in Italy. His works were always signed in Greek and usually read, “Ennion made me.” This is a typical signature for Roman glass, as is “Let the buyer remember _____” (Charleston 1980) or “_____ made it” (Fleming 1997). Other craftsmen whose names have been found on their work include Jason, Meges, Meikaios, and Artas (Charleston 1980). Despite the pieces having these makers marks, it is most likely that, once the craftsman became somewhat renowned, like Ennion, apprentices or slaves were the ones making the actual pieces (Fleming 1997).

The trade networks of the Roman Empire were not used solely for the transportation of goods, but for the exchanging of ideas and techniques as well. Stuart Fleming gives the example of the “snake thread” decoration, which will be further discussed later in this paper. Developed in the eastern Mediterranean, this style was soon transferred to and further developed in the Rhineland. Also, due to various conflicts and economic disturbances in different regions throughout the duration of the Empire, it is not a coincidence that some glass types and techniques only have a western or eastern distribution (Fleming 1997).

It was the Romans who began to use glass for architectural purposes, with the discovery of using manganese oxide or antimony as decolorants to create clear glass.

Between 50 and 75 A.D., colorless glass became “the most highly valued glass...resembling rock crystal as closely as possible” (Pliny 1890). Cast glass windows began to appear in the most important buildings in the empire, including government buildings (Beyer and Kämpfer 1966) and bath houses (Stern 1999), though the transparency of the glass was nowhere near the quality we are familiar with today. This was generally due to the fact that, in their beginnings, windows were used mainly for insulation and protection, not for letting light in. Mirrors with reflective backing made of wax, metal, or plaster, as well as mosaic floors and walls began to appear throughout the empire (Trentinella 2003).

Glass is naturally green or amber in color, due to various impurities, such as iron, that are present. To obtain colored glass, Roman glassmakers added precious stones. For example, adding cobalt produced blue glass while adding amethyst produced purple glass (Whitehouse 1988).

The first glassmaking “manual” is actually a set of tablets from the library of Ashurbanipal, an Assyrian king. These tablets, which include instructions on how to make glass, date back to approximately 650 B.C. (Glass Online 2007). There are, however, no written documents describing the Roman glassmaking techniques. The only information about glassmaking that survived is *Natural History*, written by Pliny the Elder (Pliny 1890). Scholars look to modern glassmaking methods to explain possible ancient practices, as well as study the glass itself.

After the split of the Empire, eastern and western glass gradually obtained more distinct traits (Glass Online 2007). The decline of the Roman Empire and its culture slowed progress in the field of glassmaking and working through the end of the 4th and

5th centuries A.D., particularly in the west. Only the simpler glass working techniques were still in use through the Byzantine Period (Whitehouse 1988) until it was picked up again as a major art form and commodity in the Islamic Era (Trentinella 2003).

Roman Glass Types and Techniques

Blown Glass

With the invention of glassblowing, glass was no longer just a luxury item. Blowing simplified and accelerated vessel production, which enabled glass workers to produce more and caused the finished products to be less expensive (Stern 1999). Pliny the Elder mentions the Phoenician Coast as an important center for glassmaking (Pliny 1890). This is a possible site of the origin of glassblowing (Charleston 1980), as is Jerusalem (Fleming 1997). The two oldest known blown glass vessels were found in Israel: one at Ein Gedi on the Dead Sea and another in Jerusalem's Old City. Both of these vessels date to approximately 40 B.C., solidifying most archaeologist's conceptions that glassblowing originated in the Syro-Palestine area around that time (Whitehouse 1988). Several finds in Italy date to 35 B.C., proving that this technique spread quite rapidly (Charleston 1980).

To blow glass, a three to five foot hollow iron pipe, which was clay until the 1st century A.D. (Fleming 1999), was used. A glob of molten glass was affixed to the end and by blowing through the pipe, the vessel was inflated (Fig. 3). It was then worked by means of swinging it through the air, rolling it against a smooth, hard surface, or using various tools. The worker would continue to blow through the pipe to enlarge the vessel

and work it as they go. Finally, it is removed from the blowpipe and the neck and rim were completed with various hand tools (Whitehouse 1998).



Fig. 3: The modern day craftsman and amateur glass blower are shown here blowing and working a glass ornament in a way similar to the Romans. (Photo: Kevin Colton, 2005)

Cage Cups

Made between 250 A.D. and the early to mid-4th century, cage cups (Fig. 4) are thought to be a specialty of Cologne glasshouses (Whitehouse 1988 and Charleston 1980). The earliest cage cup specimen was found in Athens and dates to approximately 267 A.D. (Whitehouse 1988). Cage cups were made by either casting or blowing and then cutting glass, or by trailing glass to form a netting pattern around a vessel. It was typically used to protect the vessel if it had paint or gilding on the outside. Cut cage glass was considerably time consuming and therefore, very expensive. This leads many scholars to believe that cage cups made of trails, or lines, of hot glass, considered the “poor man’s cage cup,” may have been considered a cheaper alternative (Charleston 1980 and Whitehouse 1988). Cage cups are thought to have been owned exclusively by

members of the upper levels of Roman society, due to their expense and scarcity (Whitehouse 1988).



Fig. 4: Cage cup, c. 300 A.D., cast or blown, wheel cut. (Photo: Corning Museum of Glass 2008)

Cameo Glass

The majority of cameo glass vessels date to 27 B.C.-68 A.D. It later emerged again for a brief period in the 4th century. Inspired by Hellenistic vessels and other items carved from onyx and agate (Charleston 1980), the preferred color scheme for Roman cameo glass was opaque white on dark, translucent blue, though there were occasionally other colors used (Trentinella 2003). Many cameo vessels depict Dionysiac scenes (Fig. 5), as well as scenes from epic legends (Cool Root 1982). This style probably originated in Alexandria, Egypt, and then spread to Italy. Cameo glass was highly prized among the elite of Rome, as it was the rarest and most ornate form of luxury glass vessels (Whitehouse 1988). Creating a multilayered template required much time and skill (Trentinella 2003).

There were two ways to create a cameo object. The first way was called “flashing,” and involved the glass object being “flashed,” or dipped, in several layers of one color, usually dark blue, and then several layers of another, usually opaque white. The object would then be carved, cut, and polished, using hand tools and possibly a rotating wheel, to create a relief design (Whitehouse 1988). In the second method, called “casing,” the darker-colored glass would be blown into a preformed vessel of the lighter-colored glass that had openings in it. Thus, the dark glass was “cased” in the lighter colored glass (Charleston 1980).

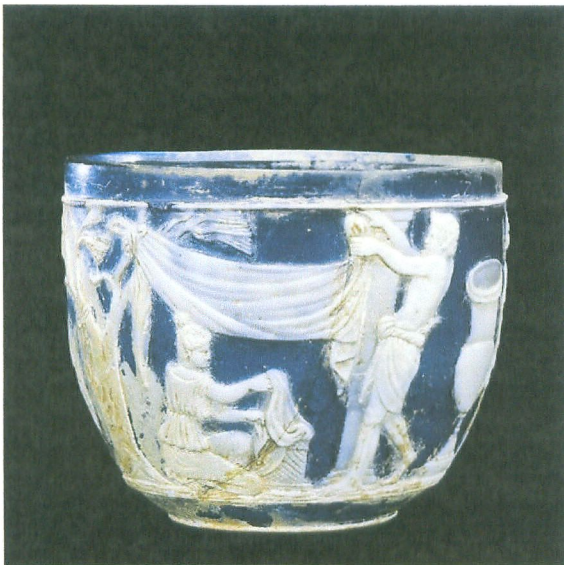


Fig. 5: The Morgan Cup, c. 1st cent. A.D., cameo glass
(Photo: Corning Museum of Glass 2008)

Cast Glass

The most popular glass forming technique until the invention of blown glass, glass casting was most likely brought to Italy by way of Alexandria, Egypt. Cast glass was of a much higher quality than the first items made by blowing (Fleming 1999). Glass was cast in two ways: either by pressing or slowly melting small glass fragments or powdered glass into concave molds (Whitehouse 1988), or by sagging soft sheets of glass

over convex molds (Trentinella 2003). The molds were usually made of metal, ceramic, or wax. In the case of wax molds, the liquid glass would harden in the mold, and the wax would later be melted off to prevent damaging the glass object during extraction (Whitehouse 1988). This process was called the “lost-wax method”. Cast glass production did suffer slightly with the invention of blown glass, but it was never fully replaced by the new technology (Trentinella 2003).

Enameled Glass

Produced in Syria, Egypt, and Italy, and then later in Cologne, enameled glass was made by mixing a low melting temperature powdered glass with an oily medium, and then painting it onto a glass vessel with a higher melting temperature. The enamel adhered to the vessel as the temperature was raised in the furnace to burn off the medium. Enamels were usually opaque and were often affixed to opaque bases. If gilding was applied, it was in the form of gold leaf or powder and fired after the initial application of the enamel (Charleston 1980).

Engraved and Cut Glass

In Roman times, there were two ways to engrave glass: using a point made from a material harder than glass, or using a wheel with a powdered abrasive material. Wheel-engraved glass usually produced more quality products. Similar to ancient gem engraving,

“A cutting head driven by a bow lathe [is used] – that is, by a cord that takes a turn around the spindle of the lathe and is attached at both ends to a curved piece

of wood. By pushing the bow backward and forward, a swift rotary movement is imparted to the spindle” (Charleston 1980).

Pliny mentions some of the abrasives that were used by semiprecious stone workers, including “sand from Naxos” (emery), as well as powdered pumice (Pliny 1890 and Whitestone 1988). This style of glass was developed by the 1st century B.C. and spread northward from Egypt to Italy and the Rhineland (Charleston 1980).

Gold-Band Glass

Adapted from a Hellenistic glass technique, gold-band glass is made when gold foil is sandwiched between two pieces of colorless glass (Whitehouse 1988). The glass is then either heated and expanded, causing the foil to “shatter” (Fig. 6a) (Charleston 1980), or left as a desired image (Fig. 6b). In the latter case, a second layer of glass would be fused over the gold foil to provide protection, either by heating both elements until fused or by heating the first piece of glass and inflating a hot bubble of glass against it. The rim and walls of the vessel could easily be shaped by heating and tooling. These techniques were used to make everything from medallions with portraits to plates, bowls, and “gold glasses” (Whitehouse 1988). Gold-band glass objects, most of which were commissioned works (Cool Root 1982), are often found within catacombs, underground tombs where Jews and Christians would bury their dead (Whitehouse 1988). The upper classes of Augustan Rome valued gold-band glass due to its seemingly luxurious style and extravagance (Trentinella 2003).

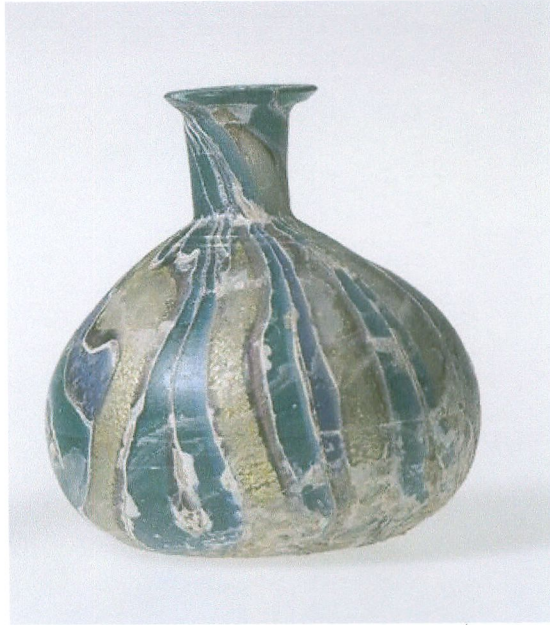


Fig. 6a: Gold-band glass bottle, c. 1st cent. A.D.
(Photo: The Metropolitan Museum of Art 2006)

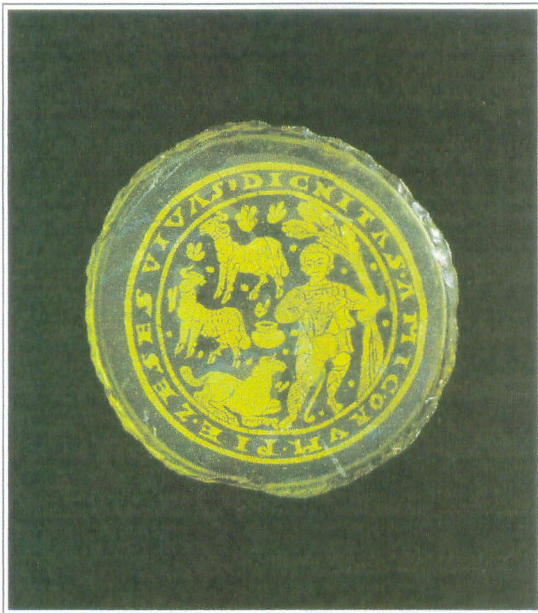


Fig. 6b: Gold foil between two plates of colorless glass, 4th cent. A.D.
(Photo: Corning Museum of Glass 1988)

Mold-Blown Glass

The inflation of a glob of glass inside of a mold was discovered in Syro-Palestine, probably in the first century A.D. Mold-blown glass was another style that sped up the

pace of glass production and the technique spread quickly (Whitehouse 1988). A craftsman would create a mold made of a durable material, usually baked clay, but sometimes wood or metal. The mold would be made of at least two parts so that it could be opened and the finished product could be easily removed. The glassmaker would blow a mass of melted glass into the mold and inflate it to obtain the shape and pattern of the mold (Fig. 7a). They would then remove the vessel from the mold (Fig. 7b) and continue to work the glass while it was still hot and soft, forming the rim and adding handles, if necessary. Meanwhile, the mold could be reassembled and used again (Neuburg 1962).

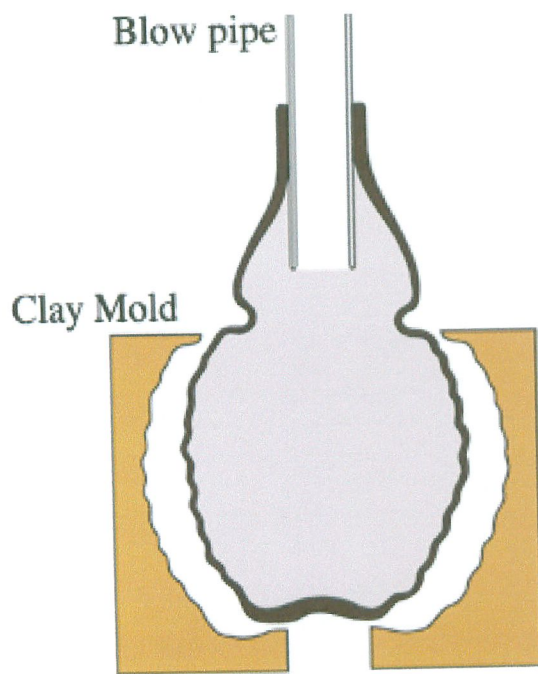


Fig. 7a: Diagram of mold-blown glass
(Image: University of Pennsylvania
Museum 2007)

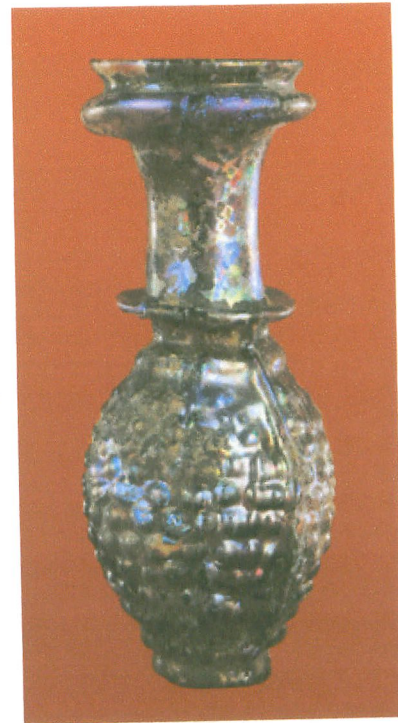


Fig. 7b: The finished product of
Fig. 7a, 3rd century A.D.
(Photo: University of Pennsylvania
Museum 2007)

Mosaic Glass

Brought to Italy by eastern Mediterranean Hellenistic craftsmen, mosaic glass (Fig. 8a) was initially seen in the late 1st century B.C. (Whitehouse 1988). Also called *millefiori*, which means “1000 flowers” in Italian (Cool Root 1982), the technique used to produce these brightly-colored creations was arduous and time-consuming. Rods (made from a single blob of glass) or canes (made from multiple rods of different colors which have been fused by heating) of glass were created and stretched to reduce the size of the design in the cross-section, then sliced into either small circles or strips (Whitehouse 1988). They were then placed next to each other, heated until they fused, and draped over or into a mold to give the object its intended shape (Trentinella 2003). Errors could be covered up by adding extra pieces of glass and reheating the entire piece (Whitehouse 1988). Cane patterns were usually limited to spirals, stripes, and “starbursts” (Fleming 1999). To make the rim of a mosaic vessel, a cane, usually twisted to give a more stimulating visual effect, was applied (Whitehouse 1988).

Ribbon mosaic items (Fig. 8b) came about after the initial use of mosaic glass, the first known vessel being found in a shipwreck between Crete and the Greek mainland that dates to between 80 and 50 B.C. Instead of slices of glass, ribbon mosaic items are made up of lengths of rods placed in neat geometric patterns and heated until they fused (Whitehouse 1988). The sheet of hot glass is then sagged over a mold and left to harden (Charleston 1980). Like most mosaic glass, ribbon glass is very brightly colored (Whitehouse 1988).



Fig. 8a: Striped mosaic bowl, c. 1st cent. A.D.
(Photo: University of Pennsylvania Museum 2007)

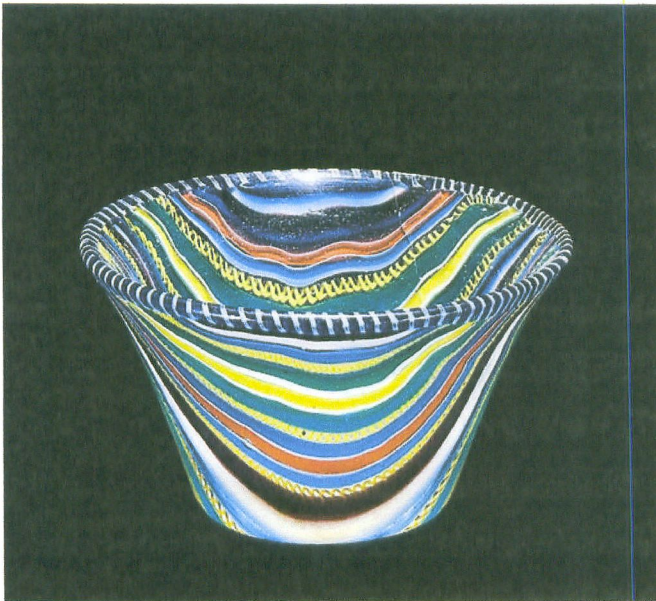


Fig. 8b: Ribbon glass cup, c. 25 B.C.-50 A.D.
(Photo: Corning Museum of Glass 2008)

Snakethread or Trailed Glass

Snakethread or trailed glass (Fig. 9) was made by applying threads of soft glass to preformed objects, usually forming geometric patterns or animal shapes. The soft threads were often then pressed with a serrated tool, or a tool that produced a waffle pattern.

Originally made in the first half of the 2nd century A.D., this style has been found mainly

in Cologne, but also in certain areas of the Near East, such as Cyprus, Greece, Syro-Palestine and Italy. Eventually, gilt threading became popular, as well as untooled threads (Charleston 1980). A similar decorating technique was called “blobbing.” Instead of threads, small blobs of molten glass were applied to a vessel and allowed to cool (Whitehouse 1988).

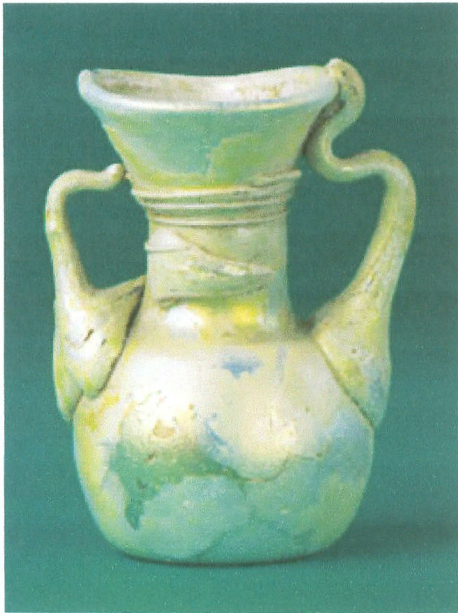


Fig. 9: Glass pitcher with trailed design around neck, 4th century A.D. (Photo: University of Pennsylvania 2007)

Speckled and Dappled Glass

Originating in Northern Europe in the second half of the 1st century A.D. (Charleston 1980), the speckled (Fig. 10) and dappled decorations consist of a heated glass object being rolled in chips of glass or the chips being dropped onto it. The object was then reheated to fuse the glass. It could be rolled on a slab of stone to flatten the glass pieces and produce speckled glass (Whitehouse 1988), or left as it was to obtain the desired look of dappled glass (Charleston 1980). If the glassworker chose to flatten the chips, the vessel could later be reworked or reblown, expanding and warping the pattern

to achieve a speckled appearance that resembled the more costly mosaic glass (Whitehouse 1988).

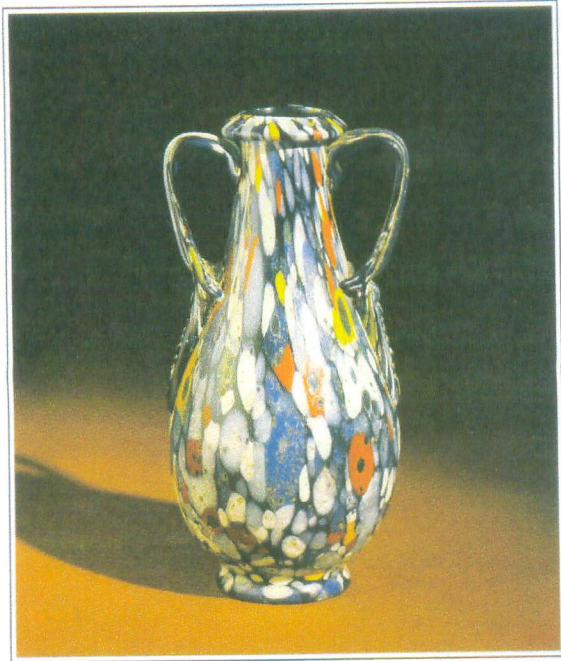


Fig. 10: Speckled Glass Vessel, 1st century A.D.
(Photo: Corning Museum of Glass 1988)

Roman Glassmaking at Archaeological Sites

Glass in the archaeological context is particularly helpful in dating sites, as techniques and styles changed over time. Glass factories were built well away from settled areas, as the heat and smoke created in the furnaces disturbed the city population so much that regulations were put into effect to keep citizens safe and content (Kudish-Vashdi and Baruch 2008). Large blocks of raw glass would be made, often up to ten tons per furnace firing, and then broken into chunks for exportation. Though there is some evidence of glassmaking in Egypt, where a major source of soda exists, (Freestone 1999) to date there are only two known glassmaking sites in the entire Roman Empire: Beit She'arim and Beit Eli'ezer, both in modern day Israel (Fleming 1997). The Belus River

in northwestern Israel provided an excellent source of sand for glassmaking, making these two nearby sites ideal for glass production (Freestone 1999). Beit Eli'ezer is also right on the Mediterranean Sea, while Beit She'arim is only twenty kilometers away, providing excellent access to trade routes throughout the Empire and the rest of the world.

Beit She'arim is now an Israeli National Park and lies ten kilometers southeast of modern day Haifa on the main road to Nazareth (Fig. 11a-b). Originally both a Hellenistic and a Roman city, its famous catacombs have many calling the ancient necropolis "Israel's Petra." First inhabited in the 9th century B.C., it reached its peak during the 2nd and 3rd centuries B.C. In 351 A.D., the city was nearly destroyed by Roman legions during the Gallus Revolt (BibleWalks.com 2008).

One of the catacombs at this site was employed as a glass factory after its initial funerary use (Jewish Virtual Library 2008). Within it sits an enormous piece of ancient glass *in situ* (Fig. 11c) (Mazar 1973). Found at the bottom of a cistern and weighing over eight tons, it is not clear for what this large piece of unworked, raspberry-colored glass with green streaks was going to be used. Experts speculate that it is likely the remains of a single chamber tank furnace (Sass 1999) and is thought to date to between the 4th and 7th centuries A.D. (Jackson-Tal 2004). Made using a later technique that involved potash instead of the usual natron, the ingredient combination caused the glass to be high in lime and may not have completely melted while being heated. Air circulation within the catacomb may have prevented the furnaces from reaching the high temperatures necessary for glass manufacture (Freestone 1999). There are also 130 limestone

sarcophagi at Beit She'arim that were later broken and used for lime in glass manufacture (Jewish Virtual Library 2008).

Archaeologists at Beit Eli'ezer, a second city of Roman glass manufacture near modern day Hadera (Fig. 11a-b), have discovered 17 tank furnaces used in glass production (Gorin-Rosen 1993). Similar to pottery kilns, these furnaces created raw glass slabs similar to the Beit She'arim slab (Freestone 1999), though made of the original soda, lime and silica recipe (Stern 2001). This site dates to later in the Roman Empire, around the 6th and 7th centuries A.D. (Fleming 1999). Glassmakers here were able to produce eight to ten tons of glass every time the furnace was fired (Gorin-Rosen 1993).

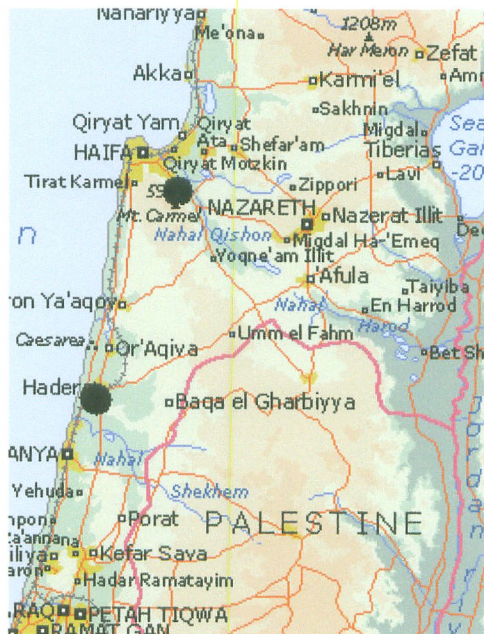


Fig. 11a and Fig. 11b: Modern day Israel with focus on Beit She'arim (north) and Beit Eli'ezer (south)
(Images: Mideast Web for Coexistence 1999)

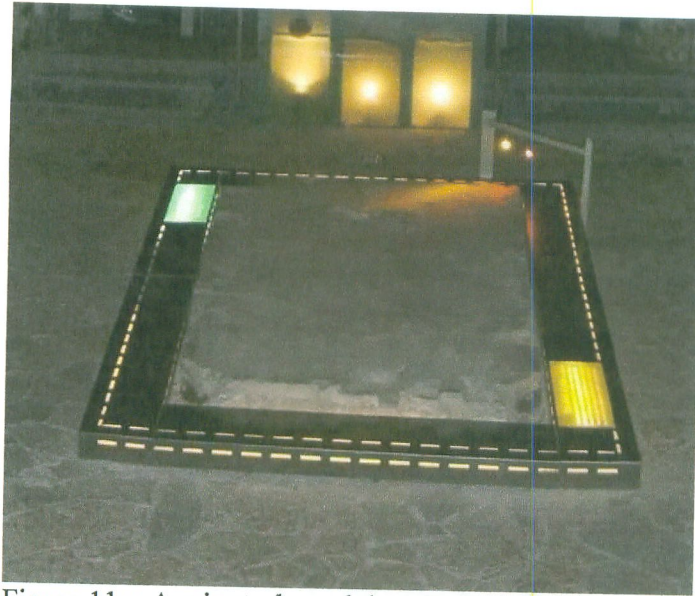


Figure 11c: Ancient glass slab at Beit She'arim
Photo: Meisner 2007

The earliest evidence in the Roman Empire of working glass into vessels is a series of furnaces in Cologne and Avenches on the Rhine River (Fig. 12 a). They date to the middle of the first century A.D. (Fleming 1997) There was also a large glass industry at Beit She'an, which the Romans called Scythopolis, in Israel beginning in the early 1st century A.D (Mazor and Bar-Nathan 1998). Furnaces attributed to glass working in Jalame, Israel, date to the 4th century A.D (Fig. 12b) (Weinberg 1988). Glass stock for this site probably came from Beit She'arim. There are many other small towns throughout the Empire with artifacts that point towards glass object production (Fleming 1997).



Fig. 12a: Map of modern day Western Europe with focus on Cologne, Germany (north) and Avenches (south).
Image: James Martin 2006



Fig. 12b: Modern day Israel with focus on Jalame (west) and Beit She'an (east).
(Image: Mideast Web for Coexistence 1999)

Results

According to the Composite Materials Handbook, glass is “an inorganic product of fusion which has been cooled to a rigid condition without crystallizing” (United States Federal Aviation Administration 1998). Discovered about 3000 years ago, ancient glass was made up of a combination of natural silica, soda, and lime (Fleming 1999). It was originally used for simple decoration purposes, then, as glass working technology advanced, vessels, figurines, and other objects were made. Many of these new technologies were due to Roman influence and pride in craftsmanship. As the Roman Empire increased in size and population, the demand for luxury items increased as well, and glass became more readily available to the public (Wacher 1987).

The technology of glassmaking allowed for several types of Roman glass to be made and distributed, including mosaic, gold-band, cameo, blown, and caged, engraved, enameled, snakethread or trailed, and speckled and dappled glasses (Trentinella 2003 and Whitehouse 1988). Glass stock was made in furnaces by nomadic workers who left the area and their factories when the natural resources needed to make the glass were depleted. (James 2006) The only two known sites where glass stock was created in the Empire are Beit She’arim, ten kilometers southeast of modern day Haifa, and Beit Eli’ezer, near modern day Hadera (Fleming 1997), though there are many sites attributed to glass working.

Conclusions

In 1750, Dr. Samuel Johnson said,

Who when he saw the sand and ashes by a casual intenseness of heat melted into a metalline form, rugged with excrescences and clouded with impurities, would have imagined that in this shapeless lump lay so many conveniences of life as would, in time, constitute a great part of the happiness of the world (MacFarlane 2002).

Glass has indeed become a convenience for people worldwide since its original discovery in the Middle East and its true potential realized by the Romans. Even before that, when natural glass was used by Stone Age man, it was a great commodity and an excellent raw material for tools. Thus, glass has a long history, but it was within the Roman Empire that glass and glassmaking technology evolved most drastically and spread unfailingly to the rest of the world.

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