The World of Beads Monograph Series: 5

A HANDBOOK OF BEAD MATERIALS

PETER FRANCIS, JR.

LAPIS ROUTE BOOKS

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I N T R O D U C T I O N

It is impossible to classify a bead without knowing the material from which it was made. This Handbook provides information for the necessary first step in bead identification. It should be obvious that this information alone is not enough to classify every bead. For one thing, many bead materials are very difficult to recognize in their present state. Additionally, knowing the material alone does not pinpoint the bead's origin.

Though attempting to be as complete as possible, this work cannot be comprehensive. This is due to the youth of bead research and the limitations of the author. Any additional information the reader may provide would be welcomed. The reader is cautioned that he or she is assumed to have a basic knowledge of beads. Terms not defined herein may be found in the Short Dictionary published in this series.

The first of six parts of this Handbook outlines testing equipment and methods for determining the materials of beads. The rest is divided into five sections: glass, stones (rocks and minerals), organic materials, plastics, and faience.

Each section has its own "personality." As glass analysis is difficult, we present a consideration of manufacturing techniques and a discussion of glass ingredients aimed to help the reader understand more about glass. The mineral and organics sections include extensive lists of specific materials that have been used for beads. The plastics section has considerable background matter, for though we are familiar with the substance, it is often ignored by bead collectors from a lack of sympathetic understanding.

Section One:

E Q U I P M E N T   A N D   T E S T S

1.1 EQUIPMENT The Handbook tests use common household items: a good magnifying glass, a long needle or pin, a knitting needle or awl, an unglazed tile, tweezers, a penny, a pocket knife, a piece of glass, and two heat sources: the kitchen stove and a candle.

The advantages of simple tests are obvious; their disadvantage is that they are limited. Some chemicals, particularly hydrochloric acid (HCl), are especially useful. These can be bought or perhaps used in a local high school laboratory.

1.2 SENSORY TESTS Your five senses ultimately communicate all test data. Our eyes are especially important. Color, luster, and fine details are vital clues. Many materials are recognizable on sight. A good hand lens is invaluable; keep one handy and use it often.

Tactile sensation, warm/cold (better against the cheek than in the hand), soft/hard, heavy/light, are also important. Our teeth are very sensitive to soft/hard; test a bead by lightly tapping it against the front teeth. With practice, starting with things you know, you can distinguish many materials in this way.

Smell is important in some of the following tests. But be careful! Fumes such as succinic acid (from amber) or formaldehyde (some plastics) can be dangerous. Do not inhale deeply and overexpose yourself.

1.3 HOT POINT TEST Heat a long metal knitting needle or wooden handled awl at the stove or a candle (don't get wax on it). Placing the point into the perforation, observe any melting, smoking or scent. This is useful for soft materials which appear similar to the eye and with the tooth test.

1.4 STREAK TEST Primarily for minerals; rub the bead across an unglazed tile or back of a glazed tile. If a mark is left, the color is often different from the color of the mineral itself.

1.5 HARDNESS TEST An especially useful test for relative scratchability. In 1822 F. Mohs proposed a scale of minerals from 1 to 10 (with ½ and ¼ steps) which was so simple and practical that it is still widely employed:

1 Talc (softest) 2 Gypsum 3 Calcite (one face)
4 Fluorite 5 Apatite 6 Orthoclase Feldspar
7 Quartz 8 Topaz 9 Corundum 10 Diamond

You can assemble these minerals from a rock shop or use more common objects:

2¼ Fingernail 3 Copper penny 5 Penknife blade
5½ Window glass 6½ Tempered steel file

You need a point to scratch with and a clean surface to scratch. A bead that scratches glass but not a file, and is scratched by the file has a hardness of 6 (written H 6). The hardness of some objects such as glass vary. We rarely need to test above H 7½, as the precious stones were not often used for beads.

1.6 SPECIFIC GRAVITY Very useful in mineralogy, but not much needed here. Sp. Gr. can be judged with some experience, the feel of light/heavy in the hand. Quartz (Sp. Gr. 2.65) is of medium weight. If used, a good balance is needed; a trip to the lab may be necessary.

1.7 PLASTIC FLAME TEST This often destroys the bead; be sure you can spare it. Hold it in the candle flame with tweezers (keep away from wax) and bring it in and out observing melting, charring, burning, extinguishing, and any scent. Again, you are cautioned when smelling.

1.8 BRINE FLOATATION TEST Into three 8 oz. glasses of warm tap water dissolve table salt, pouring it in slowly while stirring. The first glass takes 1 level tablespoon, the second 2 tbs, and the third 4 tbs. Beads (especially amber) are tested to see if they float. Before testing, wet the bead and blow through the perf. Afterwards, wash in water and a mild soap, then rinse.

1.9 HYDROCHLORIC ACID EFFORVESCENCE A drop of dilute hydrochloric acid (HCl) will bubble and froth on some materials with a calcite base. The acid may be diluted: one part acid to five parts of water. Sometimes it needs to be slightly warmed.

Section Two:

G L A S S

2.1 BACKGROUND Any discussion of this complex substance becomes a complex subject. It is easy to distinguish glass from other materials, but we need to know more, because glass is the most important bead material and has been long used because it is cheap, durable, and can be made in a great variety of colors and shapes.

Glass origins are not entirely clear, but it was first made in the Caucasus or Mesopotamia in the 3rd mellinneum BC. Egypt used it heavily by 1500 BC, and it was widespread by 500 BC. Today it is universal, and glass beads are made in many lands by many means.

Glass analysis is laborious, exacting, expensive and beyond the reach of most of us. Lacking simple tests, we take two approaches to glass beads. Knowing how they were made often helps identify a specimen. We also discuss glass ingredients, which helps us to understand glass better and enables us to read published glass analyses (many of them are of beads).

T E S T S: Glass Cool to the touch, glassy luster, a sharp, hard feel on the teeth, H $5\frac{1}{2}$. Recognizing the manufacturing process also helps distinguish glass beads.

Materials confused with glass include glazed stone or clay and enameled metal. These have a glass coat over a core material, glass is homogeneous throughout.

Silica minerals (section 3.2) also confuse, but they a) are harder than glass, b) usually break smoothly, while glass has a clam-like (conchoidal) break, and c) are usually perforated from both ends with a joint in the center. This can be felt with a long pin; glass beads (unless drilled) have straight perforations.

* * *

2.2 HOW GLASS BEADS ARE MADE Some of the many ways of forming glass into beads are so old and widespread that they tell us little or nothing about origins. But other methods are specialized and restricted and can point to manufacturing centers in many cases. Techniques have been arranged from the oldest and simplist to the most modern, giving an idea of the growth of glass beadmaking processes through time.

2.3 SMALL-SCALE GLASS BEADMAKING The simplist and oldest methods of making glass beads require only a small mud furnace and a few workers. Most of these techniques are still used, often producing beads of great beauty.

1 Furnace-winding Molten glass is removed from the furnace by dipping a long iron rod (mandrel or pontil) into the melt and twisting to build a bead-sized bit on the end. The bead can be smoothed on a flat plate (marvered), pressed with paddles, molded in a simple die, or decorated with other colored glass. Work must be quick, as rapid cooling cracks the bead; it is often reheated while being worked. In a few seconds, a bead is made and knocked off the rod (which contracts faster than the glass). The bead is placed a bit away from the heat where it will cool slowly (anneal), preventing internal stresses from cracking it.

2 Scoop-winding Glass is removed on a scoop and trailed on a turning rod outside the furnace, building up the bead. Again, work is quick and often involves reheating. Shaping and decoration are the same as above. Sometimes the rod is rotated in the air, the motion giving the glass bead a spherical shape.

3 Flow-molding Molten glass is run through channels of flat molds in the same way metal is often cast. Now obsolete, the process was used in Mycenaea for flat pendants in the 2nd millennium BC.

4 Hand-blowing Beads are only rarely blown into shape freehand like a bottle is made. Tubes are blown by hand and quickly pressed into molds forming multiple connected beads which are then cut apart.

5 Dry molding (Powder glass beads) Crushed glass from old bottles, new beads, or bought in packets is poured into holes in clay molds with green sticks in the center of the holes. The molds are heated in a furnace, the glass refuses into a new shape, and the sticks burn away leaving a perforation. Used especially in West Africa, but also in East Africa and America: there are many variations.

6 Heating and piercing A bit of glass is heated to a roundish shape or dropped on a flat plate and then pierced with a nail or pointed wire. Not common, but used as far apart as India and pre-contact Peru.

2.4 <u>INDUSTRIAL GLASS BEADMAKING</u> Bead industries with large markets developed industrial methods to make beads in volume. A few factories make glass in special shapes which are formed into beads by other workers. Such a 2-step industry was the pattern in ancient Egypt and India, and is used in Venice, Bohemia, and elsewhere. Large volume and specialization mark this stage.

1 <u>Folded beads</u> Glass ribbons or plaques were made by the glassworker. Beadmakers softened the flat glass on a lamp, folded it over a wire, and joined the ends.

2 <u>Drawn beads</u> Glass tubes are made in several ways: the Romans dipped wires into glass, removing it when the glass cooled. In south India a continuous tube is drawn from the glass-coated end of a heavy pipe kept warm in the furnace while the other end sticks out of the furnace drawing in air to prevent the tube from collapsing.

In the best known method a master blows a bubble in a cylindrical mass of glass (parison), a boy attaches a rod to the free end and pulls it out by running down a long gallery. A single man can draw a tube by securing one end. Drawn tubes do not need annealing. They are cut into bead sizes and usually briefly heated to round them off.

3 <u>Lamp-wound beads</u> Solid glass rods (canes), made like the tubes above but without holes, are remelted by a lamp (hence the name) and wound around a wire. While warm they can be pressed, molded, or decorated with differently colored glass from other canes.

4 <u>Tong-molding</u> Canes are heated, snipped off the right size, and squeezed into a hinged mold, with a rod pushed through for the perforation. Molds were coated inside with charcoal for a "polish." The Bohemians often hand-ground these beads to add facets or remove the mold seam. Mandrel-pressed beads were not perforated through, then faceted, and struck to break out the glass over the small end of the conical hole.

5 <u>Blown from tubes</u> A tube is heated and air blown in to expand it. It may be hand shaped. More often it is blown into a mold, as with many false pearls.

6 <u>Fancy canes</u> Glass canes with a continuous design along the cross-section are an important bead feature. They are made by bundling unicolored canes together and fusing them or by building up the design

while the glass is hot. In either case, they are drawn out to produce long canes which are usually sliced and put on beads for decoration. Cane sections may also be perforated through the edge or 3 or 4 heated together around a wire to make a compound bead.

2.5 <u>MECHANIZED BEADMAKING</u> Slower to be adopted in the glass industry than elsewhere, mechanized work was first accepted in the "newer" bead centers: Bohemian, Austria, Germany, and Japan. It is gaining ground, and even replacing costly labor in Venice.

1 <u>Mechanized drawing</u> A number of processes have been devised, the best known being the Danner method in which glass heats in a series of chambers, emerging as a sheet covering a thin cone through which air is blown (the mandrel; note change of function in this word.) A die locked on the end gives any desired cross-section. The tube is supported by rollers for some ways to cool, and then is pulled forward by two endless chains. The cutting and tumbling stages are also mechanized.

2 <u>Mechanized molding</u> Glass is injected into two-part platinum coated dies with a platinum rod inside for the perforation. Platinum is ideal for engraving designs and prevents the glass from sticking.

There is an early adaptation by the Bohemians, apparently from a method for making buttons patented in 1841 by R. Prosser from dry powdered glass. We are not sure how it worked, but the beads are unmistakable.

3 <u>Mechanized blowing</u> Mechanically drawn tubes are fed into a series of heated molds and blown with air to expand them. Later the beads are cut apart.

4 <u>Mechanized winding</u> The mandrel rotates automatically as a pre-measured amount of glass feeds onto it.

T E S T S: Glass Beadmaking Processes Wound beads have their fabric and inclusions running around the perforation. Inclusions include foreign matter (stone) and gas, called seed (less than 0.5 mm), bubbles (0.5 - 2.0 mm), or blisters (more than 2.0 mm). Furnace- and scoop-wound beads are nearly impossible to distinguish. Lamp-wound beads sometimes have a cord effect. Perforation deposits give clues. Furnace-wound beads have a black layer of iron oxide. Many lamp-winding centers (Japan, China, Bohemia, Austria, Germany, India, but not Venice) coat the wire with china clay (kaolin), which helps remove the cooled bead and leaves a white deposit. Mechanized wound beads also have this deposit. It wears off in use.

Drawn beads tend toward cylinder shapes. Fabric and inclusions run along the perforations. Most tiny beadwork beads are drawn. Hand- and machine-drawing are virtually indistinguishable.

Molding leaves a seam around the bead; check to be sure it actually encircles the bead. It may go around at any angle. Molded wound beads (2.3.1/2/3) retain their wound structure, while tong- and machine-molded beads (2.4.4; 2.5.2) are homogeneous. A molded bead with a ground-off seam has a flat band encircling it; this can be obliterated with faceting. Mandrel-pressed beads (2.4.4) have conical holes and broken glass around the small opening. Prosser beads (2.5.2) have equatorial bands with one edge sharper than the other, and one end pitted unlike the rest of the shiny surface. Machine molded beads have perfect, flush seams, sometimes as a black line on a dark opaque bead.

Dry molded beads (2.3.5) have granular surfaces unless they are reheated and polished. Pierced beads (2.3.6) are irregular in shape with conical holes. Flow-molded beads (2.3.3) usually have an undecorated side and poor molding. Folded beads (2.4.1) have a depressed joint line (unlike a seam) on one or sometimes two sides connecting the perforation openings.

* * *

2.6 HOW GLASS IS MADE There is no chemical formula for glass. It is a state of matter in which inorganic crystalline material is fused and cooled to rigidity without crystallizing. Technically it is a liquid in disequilibrium; in practice it is used as a solid.

The primary element in common glass is silica, usually obtained from sand. Its high melting point (1723° C-- far too high for ancient furnaces) is lowered with an alkali flux, soda or potash. These melt easily, but form a water soluble material (water glass), which must be stabilized, usually with lime or lead. The ancients do not seem to have known about this last point, and the necessary lime was introduced accidentally in the form of bits of shell in the sand.

Generally, "glass" means this silica-alkali-lime combination, while "crystal glass" is made of silica-potash-lead. The many special glasses produced in the 20th century do not interest us here.

Traditional glassmakers needed sand, alkali, and fuel. The alkali was often derived from plant ash, sometimes the plants used for fuel. Alkalies were also gathered from mineral lakes or soil encrustations. Sand, alkali, and some broken glass (cullet) were mixed and heated until they fused, then quenched with a water spray and crushed. To this "frit" colorizers were added, and this was reheated. After a long time (the old furnaces did not fire above 1050° C) the unpromising grey frit turned to a clear, molten liquid glass.

This is simplified and idealized; other processes are also used. Many glassmakers recycle old glass or use raw glass ingots (cakes) from larger centers, especially for special colors. It is rarely possible to distinguish between glass made on the spot, from recycled glass, or imported commercial cakes without analysis.

Glass analysis is more an art than a science, and the same glass analyzed at different labs can produce widely different results. Following are ingredients arranged in approximate order of importance. Some are basic for glassmaking, others color or give characteristics to glass, and others are mostly impurities.

1 Silicon (Si) Silica (SiO_2) The major component of glass, making 60 to 70% of the weight of common glass. The most stable formula for this glass is an atomic ratio of 1 alkali: 1 lime: 6 silica.

2 Sodium (Na) Soda (Na_2O) The most common alkali for fluxing silica. It makes a brighter glass (higher refractive index) than potash, and is denser. But it weathers easier, and most corroded old glass has been made with soda as the alkali.

3 Potassium (K) Potash (K_2O) The other important alkali flux, less common than soda, but not rare; sometimes the two are found together. Often analyses do not distinguish between them, as they are difficult to separate chemically. Potash glass is usually harder than soda glass, less susceptible to weathering and more easily decolorized. Thus it is especially useful for lead glass. The Bohemians and Dutch used potash from their beechwood fuel almost exclusively.

4 Calcium (Ca) Lime (CaO from $CaCO_3$) As the stabilizer for ordinary glass, lime may vary in amount from 2 or 3% up to 22 or 23% in ancient glasses. Lime purity is a concern of modern glassmakers.

5 Lead (Pb) This can replace lime as stabilizer, and especially with potash forms a brilliant, heavy glass easily colored and soft for cutting. This is "crystal" or in pure form "paste" for rhinestones. It will also aid in copper solubility in producing opaque red glass (2.6.8). In analyses, the percentage of lead is always high (when done by weight), often exceeding silica, because lead atoms are heavy.

T E S T S: Lead Glass Heavier than most glass, lead glass has a Sp. Gr. more than 3 usually, and will sink in Bromoform. A drop of hydrofluoric acid (HF) followed by a drop of ammonium sulfate (NH_4SO_4) will turn to a black spot on the glass if lead is present.

* * *

6 Barium (Ba) Also used to produce a brilliant, strong glass like lead, but easily weathered. Much less common than lead or lime glasses. Barium and lead are sometimes used together.

7 Iron (Fe) Ferrous oxide (FeO) Ferric Oxide (Fe_2O_3) Almost universal as a sand impurity and found in most glasses, it is also an important colorizer. The ferrous form (Fe^{++}) produces blue, and the ferric (Fe^{+++}) yellow. Usually found together, they combine into the familiar "bottle green." Reducing the fire slightly (closing it to starve the oxygen) brings out the blue, while air blown into it (oxidizing) will produce yellow. Large concentrations make a dark, almost black color. With manganese in the right amount it will make amber glass. Virtually all glass colors can be made with iron or copper if treated properly.

8 Copper (Cu) Cupric oxide (CuO) Cuprous oxide (Cu_2O) The chamelon of glass colorizers. The cupric form imparts a light blue, common for glass and faience. When reduced (oxygen starved) the cuprous form gives an opaque red or orange. The opaque red is an important glass color, often called "Indian red" (for India).

Small copper crystals suspended in the glass in a difficult and precise technique produce the sparkling aventurine (goldstone) glass. Colloid copper forms a ruby glass, also tricky to obtain, and used less often than gold or selenium (2.6.15).

9 Manganese (Mn) This versatile element is called "glass-makers' soap" when used to clear glass by cancelling the effects of iron. Old glass thus cleared will turn amethyst after long exposure to the sun. Large amounts will make a dark, nearly black glass. In the right combination, manganese makes black, grey, red-brown, indigo, violet, amber, and clear glass.

10 Antimony (Sb) Also used to decolorize glass, but its most important role is as an opalizer for opal glass or more commonly to opacify green, yellow, or blue glass. (Opaque red, as we have seen is from cuprous oxide.)

11 Tin (Sn) and Arsenic (As) These are also opalizers and opacifiers. Tin was used only rarely until the 13th century, and arsenic not until the 18th. Tin also produces an opaque white glass.

12 Cobalt (Co) A tiny percentage imparts a rich blue color to glass, darker than copper. It has been used since antiquity. The ultimate shade depends on the presence of other elements.

13 Magnesium (Mg) Present in nearly all glass, usually from 2 to 5%, it seems not to affect glass in any way, and is apparently only an impurity, often from the ashes used for alkali.

14 Aluminum (Al) Alumina (Al_2O_3) Another very common impurity, usually from 1 to 5%, and derived from the sand and/or the clay of the melting crucibles. It helps slow weathering, and is added in modern glassmaking for that reason. Feldspar glass beads (Bohemia, France) have high alumina contents.

15 Gold (Au) and Selenium (Se) Small amounts of colloid gold gives a ruby red glass. It is usually added to the sand and mixed as Purple of Cassius (a solution of almost pure gold and some tin). Otherwise, it is only a trace element.

Selenium is a modern substitute, giving a more garish color, widely employed, mostly with potash glass.

16 Silver (Ag) When purposely used, it gives an attractive iridescent coating to glass.

17 Chrome (Cr) An important modern colorizer. It gives green or bright yellow or, with iron, black. It also makes an aventurine, similar to copper (2.6.8).

18 Nickel (Ni) Another modern colorizer, its hue depends on the type of glass used. It is red-violet in potash glass, brown-violet in soda glass, and red in lead or barium glass.

19 Minor Ingredients Cerium (Ce) and the sulfides produce bright yellows. Uranium (U) gives a yellow with a greenish fluorescence. Grey or smoky colors are made with combinations of manganese, iron, and copper, or with copper and nickel.

20 Trace Elements In addition to elements which affect the physical or optical properties of glass, a number of minute trace elements can be detected by modern analytical means, especially X-ray fluorescence. The patterns of these elements may lead us to some conclusions regarding the origin of the glasses. This is a field still being explored.

2.7 WEATHERED GLASS Weathered, devitrified or corroded glass has been altered by two means, usually simultaneously: the leaching of soluble alkalies from the glass and the recrystallization of the silica.

The subject cannot be done justice here, but it may be useful to point out some characteristics of weathered glass. Some have finely wrinkled crusts producing a lovely iridescence on the surface. Others are hard to recognize as glass, for the surface is white and chalky; only when broken or scraped can the glassy interior be seen. Beads with decorative lines or spots may have the glass weathered differently. The decoration may fall off of the body, or it may be better preserved than the rest of the bead.

Heavily weathered glass usually indicates great age. But the reader must be cautioned that glass can be artificially weathered by several means: acid etching, pulling chips off with a glue coating, or roughening the surface and exposing it to steam.

Some investigators are convinced that glass weathers in regular cycles and that its age can be calculated by counting the weathering layers under a microscope. This exciting possibility has not been accepted by all glass authorities.

Section Three:

S T O N E S : R O C K S A N D M I N E R A L S

3.1 BACKGROUND Man's knowledge of the mineral kingdom began some 2,000,000 years ago when he first made stone tools. Though we call prehistoric times the "Stone Age," few stone beads were made, for it took a long time to learn how to turn hard stones into beads. We may always be grateful for the invention, as many stone beads are the most beautiful specimens in any collection.

The term "stone" has no scientific standing, and is used here in the broadest sense as nearly any rock or mineral. A mineral is a distinct "species" with a definite atomic structure and characterisitics. A rock is composed of minerals with less predictable natures. Most minerals and some rocks are volcanic (igneous) in origin. Rocks are usually sedimentary, built in layers by water or wind, or metamorphic, changed by pressure, heat, and chemical forces deep in the Earth's crust.

Mineralogy and petrology are detailed studies, and further reading is strongly advised for those interested in stone beads. Of course, as with all beads, nothing can take the place of experience arising from handling specimens and getting to know them first-hand.

The section begins with three important bead groups: the silicas, the metals, and clay. All other stones known to the author to have been used for beads are listed with descriptions. Tests are included in the appropriate sections, with a quick hardness chart at the end. You may want to review the hardness (1.5), streak (1.4) and HCl (hydrochloric acid) tests (1.9).

3.2 SILICA GROUP Silica (SiO_2) is the most common mineral on Earth, present in most rocks, and forming many varieties. It is hard (to H 7), attractively glassy, comes in many colors, and is the most used stone for beads.

We can divide the group into four types according to crystal structure. Quartz forms crystals (crystalline), and is usually translucent or even transparent. Chalcedony (fibrous microcrystalline) is translucent and banded, grading into agate as the banding becomes distinct. Jasper (granular microcrystalline) is opaque except on thin sections and without banding, grading into flint as the colors become dull. Opal (amorphous) exhibits a distinctive play of color when it holds water.

There are many names for these varieties. The following are known to be used for beads:

1 Quartz (Crystalline) Forms crystals, usually transluscent, glassy luster, H 7. When clear called rock crystal. Iron colors it brown/grey (smoky quartz) or golden (citrine) or, with irradiation, violet/purple (amethyst). Nickel will turn it green (plasma).

Many forms have inclusions. Fine red-golden hairs of rutile crystals form rutilated quartz or Venus' hair stone, once highly prized. The same crystals can form blue quartz by reflection due to the Tyndall effect, and are probably responsible for rose quartz, perhaps with manganese. The latter two are always turbid; the blue has a greasy luster, and the rose a cracked surface. Entrapped bubbles of gas produce milky quartz.

Bits of mica, chlorite, hematite, or goethite make sparkling aventurine. There is also a feldspar aventurine, and a glass imitation (goldstone). Enclosed asbestos makes tiger's eye (darkly banded) and cat's eye (light yellow).

2 Chalcedony (Fibrous Microcrystalline) Crystals too small to see, translucent, greasy luster, always banded (look closely), H 6½. White to blue-grey is chalcedony, red (iron) is carnelian, brown (iron) is sard, and green (nickel) is prase or chrystoprase. More than one color makes it an agate, banded agate when irregular. Moss agate (mocha stone) has fern-like growths of iron (black), manganese (red), or chlorite (green) crystals.

Perfectly straight banded agate is called onyx when it is black and white, sardonyx when brown and white, and carnelionyx when red and white.

3 Jasper (Granular Microcrystalline) Crystals cannot be seen, opaque, waxy luster, H 6½. The name is used for all brightly colored varieties: red jasper (colored with hematite), green (chlorite), or yellow (goethite). A fine black jasper (Lydian stone) is used for touchstones as well as beads. When jasper is dull black, brown, or white it is called flint or chert. Red flecks in green jasper is bloodstone or heliotrope.

4 Opal (Amorphous) Lighter and softer (H 5¼ - 6¼) than the others. Without play of light is common opal, opaque, and often forming fossils. Entrapped water makes colors play in all hues on a dominant background as white, black, or red (fire opal).

5. Alterations Many silica minerals are artificially colored. Carnelian and citrine nearly always are, the former from dull iron-rich rocks or soaked in iron-bearing nitric acid, and the latter from smoky quartz or low grade amethyst. They are heated, sometimes in a special solution. Onyx is commonly made by soaking straight banded agate in a sugar or honey solution and heating or giving an acid bath: porous layers that soaked up the honey turn black from carbonization; non-porous layers remain white. Many spectacular colors are made with modern chemicals, especially at Idar-Oberstein, Germany. Few colors penetrate deeply; a chip or broken bead will verify alterations. Except for the chemical colors, the practices are very ancient. As these stones are almost never found in nature, they are completely acceptable to the collector.

3.3 METALS Free gold and copper were the first metals used by man, cold hammered and later heated. Lead and silver were next known, both from melting shiny galena (a lead ore). Tin, mercury, and iron (first as meteorites) were the other 3 metals known to the ancients.

Metals are most often combined with each other (alloyed). The first alloy was electrum of gold and silver, both natural and man-made. Bronze (copper and tin, sometimes arsenic) was so important that we talk of the Bronze Age. Brass (copper and zinc) was a Roman invention, as was pewter (tin and lead), though the British came to be famous for it, as the metals were both plentiful on their island.

The history of nearly all metals begins with ornaments, usually beads and pendants. Gold, silver, lead, copper, tin, iron, bronze, brass, and even aluminum were first employed in this way.

Much energy has gone into imitating precious metals. A thin sheet of gold stuck with egg white was a gilting process used since Roman times. Electroplating might have been used before Christ. C. Pinchbeck invented the first successful non-gold gold imitation in the

18th century, but the secret died with him. In China a natural copper-nickel alloy called pai t'ung looked much like silver and came to be called paktong in the West, being duplicated in the 1830s as German Silver. This term was banned in the U.S.A., as it contained no silver at all.

The following is a list of alloys used for costume jewelry. The commercial name is followed by (gold) or (silver) indicating what is imitated if not obvious, the country of origin, and the precious metal content, if any, followed by the other metals. Chemical abbreviations follow this list. Remember Au = gold, Ag = silver.

1 Alger (silver) Sn, Sb.
2 Alpaca (silver) U.K. 2% Ag; Cu, Zn, Ni.
3 Argental (silver) Cu, Zn.
4 Argentan (silver) Zn, Cu, Ni.
5 Argasoid (silver) Cu, Zn, Ni, Sn, Pb.
6 Argent Français (silver) = Ruolz 20-40% Ag; Ni, Cu.
7 Argentine métal (silver) small Ag; Sn, Sb.
8 Argiroid (silver) Germany Ag plated.
9 Bandoin (silver) France 2.5% Ag; Cu, Ni, Co, Zn.
10 Bell Metal (silver) Cu, Sn. Also = pewter or bronze.
11 Chinese silver, China 2% Ag.
12 Dutch gold, Netherlands No Au.
13 EPNS (Electroplated nickel-silver) Ag plated Ni.
14 Electrum (silver) Cu, Ni, Zn. Also = Ag + Au.
15 Fahlum (silver) Sn, Pb. Stage jewelry, facets well.
16 French gold No Au.
17 French silver = Ruolz 20-40% Ag; Ni, Cu.
18 German silver Cu, Ni, Zn. Polishes well, harder than silver, good color.
19 Gold: Fineness marked in karats (also carats, usually marked K), each 1/24th part gold; 18K = 75% Au.
20 Gold filled: Usually plated with 10K Au to 5% weight.
21 Grey silver, Japan 50% Ag.
22 Guinea gold Cu, Zn.
23 Hamilton's metal (gold) Cu, Zn.
24 Jacoby (silver) Cu, Sn, Pb, Zn.
25 Japanese silver 50% Ag.
26 Lutecine (silver) France No Ag.
27 Manila gold Cu, Zn, Pb.
28 Mock silver 5% Ag; Cu, Al.
29 Mokum (silver & gold layers) Ag and Au; Cu.

30 Mosaic gold Cu, Zn.
31 Mousset's alloy (silver) 27.56% Ag; Cu, Zn, Ni.
32 Nuremburg gold (Germany) 2.5% Au; Cu, Al.
33 Oreide (gold) France Cu, Zn.
34 Ormulu (gold) France No Au, composition varies.
35 Paktong/ Pakfong (silver) China Cu, Ni, Zn.
36 Paris metal (silver) No Ag.
37 Pinchbeck (gold) U.K. No Au; Cu, Zn.
38 Prince's metal (gold) Cu, Zn.
39 Proplatinum (silver/platinum) Some Ag; Ni, Bi.
40 Rich gold metal About 10% Au.
41 Rosein (silver) 10% Ag; Ni, Al, Sn, high polish.
42 Ruolz (silver) France 20-40% Ag.
43 Shadke (gold) Japan Some Au.
44 Shak-do (gold) Japan 2-8% Au, 1% Ag.
45 Sheffield plate (silver) U.K. Ag plated Ni.
46 Similor (gold) Cu, Zn, Sn.
47 Sterling silver 92.5% Ag.
48 Talmi (gold) Best is roll-plated Au; cheaper is electroplated.
49 Tombac (gold) China 15% Au.
50 Tombac (gold) Malaysia Only Au plated.
51 Tournay metal (gold) France 15% Au.
52 Trader's gold Cu, Zn, Pb.
53 Tutenang (silver) China Cu, Ni, Zn.
54 Warnes's metal (silver) Sn, Ni, Bi, Co. Hard, costly.
55 Wersell's silver 2% Ag.
56 White gold Superior is 90% Au, 10% Paladdium. Also 50% Au/ 50% Ni, or Au + Platinum to 20% maximum, or Au + Ag.
57 White metal (silver) Various compositions, no Ag.

(Ag = silver; Al = aluminum; Au = gold; Bi = bismuth; Co = cobalt; Cu = copper; Ni = nickel; Pb = lead; Sb = antimony; Sn = tin; Zn = zinc)

T E S T S: Metals Unfortunately, thumbnail tests for the metals and alloys are difficult, especially with the precious metals. Experience with a touchstone can be beneficial; a knowing worker can distinguish to 1% of the gold content of electrum.

Aluminum: light, easily scratched by knife.

Brass: High gold color, scratches with knife, resists corrosion.

Bronze: darker, harder than brass, casts well, patinas green.

Copper: red color, scratches with knife, patinas green.
Gold: distinct color, heavy and soft, incorruptible. Spot of nitric acid on object or touchstone streak will not affect gold, but blackens other metals.
Iron: dark, attracted to magnet, rusts.
Nickel: light color, attracted to magnet.
Silver: buffs to characteristic sheen, tarnishes black, acid taste on tongue between silver and copper.

* * *

3.4 CLAY The product of heavily weathered and pulverized rocks, especially feldspars, clay is also the general term for any earths which are plastic with water and harden when heated. This is why it is so useful.

Clay figurines were made 20,000 years ago; pots and jugs 10,000 years ago. It has low status as a bead material, and is less well known than some others. This is a shame, as clay beads are very ancient and still produced today; it is a favorite medium for many young contemporary American beadmakers.

In general, clay falls into three groups:

1 Earthenware The common clay of pots and many beads. There are many sources of clay; it is usually grey, pink, or yellow when dug out, due to iron. When heated in a closed space it turns red (terra cotta), and in the open turns black. Green clays (chlorites) and white clays (pure feldspar) are also used.

Clay is easily shaped and variously decorated. A pigment coloring is called painting. A thin coat of finely ground clay is a slip. It can be burnished (polished) by being rubbed with anything hard. In India glass and stone beads are used to burnish pots before firing; another interesting use for beads. Clay is often glazed with a thin coat of glass. Some modern clay beads are decorated with decals.

2 Soft Porcelain Also known as "soft paste," it resembles porcelain. The Chinese made it by adding some steatite to kaolin clay; the surface then crazes. European and English (Bone) soft porcelains were made to imitate real Chinese porcelain.

3 Porcelain This is made from pure, white kaolin, from weathered white feldspar. The Chinese invented it and Europeans struggled for a long time to duplicate it. It is white and usually glazed. When unglazed it is

called bisque (bisquit). It has the same properties as porcelain which is glazed. Stoneware is a true French porcelain, also called Gres or Gres Kaoline.

TESTS: Clay Earthenware is dark and porous, and can be scratched with a knife. Soft porcelains can also be scratched with a knife, but are not dark nor porous. The Chinese variety is white with an undulating and often crazed surface. The European is grey or greenish and translucent. English Bone is semi-opaque, but very white. True porcelain cannot be scratched with a knife and is translucent when thin; Stoneware is greyish.

Be sure you are testing the core, not the glaze, which will test like glass. Clay deposits in glass bead perforations are loose and can be removed with a pin.

3.5 STONES USED FOR BEADS These rocks and minerals have been recorded used for beads. ** marks important ones.

1 Alabaster Fine-grained, light to yellow in color, glassy to greasy luster, H 2-2½. Effervesces with a drop of HCl. Often strongly banded and mistakenly called onyx. True alabaster is hydrated (water-holding) calcium carbonate. See also gypsum (3.5.23).

2 ** Apatite Named from the Greek for deceit because the large, varied-colored group was often mistaken for other minerals. Usually translucent, a glassy, oily, or resinous luster, tends toward dichromism (color change depending on whether the light strikes it from the front or back), H 5. The blue and green varieties are old bead favorites. Odontolite is apatite replacing bone and is known as fossil or bone turquoise.

3 Argillite, Catlinite Similar reddish clays which harden to about 5 when exposed to air or heated. Catlinite (named for photographer G. Catlin) was widely used in North America for pipes: pipestone.

4 Basalt Dark, heavy, dull volcanic rock, usually fine-grained and with small air cavities.

5 Bauxite A reddish leached clay of tropical soils, high in aluminum and iron. Hardens in the air or on heating. A favorite for beads in West Africa.

6 Beryl Precious beryl is green (emerald) or pale (aquamarine), H 8. Natural hexagonal crystals were popular when drilled for beads in ancient Rome.

7 Breccia Conglomerate rock which contains cemented angular fragments of minerals.

8 ** Calcite Translucent, glassy to greasy luster, H 2½ on one face, 3 on cleavage (when broken) face. The clear variety, Iceland spar, produces a double image when laid upon a line. Calcified fossil wood and cave stalactites have also been used for beads. Effervesces with HCl. Important rock-forming mineral.

9 Chalk Fine, white, powdery limestone, H 1-1½. With HCl effervesces quickly.

10 ** Chlorite Mostly green (chloros is Greek for green), structurally related to mica so it breaks into thin sheets. The pinnate variety breaks into sheets a mm or more thick, perfect for flat beads or pendants. H 2-2½, luster glassy, greasy, on break is pearly.

11 Cinnabar Bright translucent red, H 2-2½. It is very heavy (Sp. Gr. 8); this alone usually identifies it.

12 Corundum Red (ruby) and blue or white (sapphire) are precious and very hard (H 9). Rarely used for beads. Emery, an abrasive long used for bead drilling, is a mixture of corundum and other hard minerals.

13 Dolomite (the mineral) Translucent, glassy to pearly, clear, brown, pink, or green, H 3½-4.

14 Epsomite Salts precipitated in springs, streams, or caves. White, silky to earthy, H 2-2½. Dissolves in water and tastes bitter.

15 ** Feldspar Complex silicates; the most abundant mineral group on Earth. Uusually glassy luster, H 6. Some important varieties: Amazonite is green microcline with wisps of color throughout. Moonstone is silvery-blue and seems to hold its own light. There are two feldspar aventurines: sunstone, yellow-brown with hematite, and a green mica variety from India. Labradorite shows a play of blue/green when moved.

16 Fluorspar Cubic fluorite crystals in many colors, but mostly violet/purple, H 4.

17 ** Garnet Among the hardest common bead materials, they have long been popular, and come in many colors. The deep red almadine (almadite) has H 7½; others run from H 6½, but most are 7¼. Hardness and deep colors are usually enough to identify.

19 Goethite Dark, fibrous, opaque, silky to metallic luster, brown streak, H 5-5½.

20 Graphite Opaque, black to steely grey, metallic luster, black streak, H 1-2.

21 Granite An igneous rock with a variety of colors and compositions, chiefly quartz, feldspar, and mica.

22 Gypsum Translucent, usually colorless or white with glassy to resinous luster, H 2. Clear crystals (selenite) and the hydrated form (also called alabaster) are the varieties most used for beads.

23 Halite Table salt, easily breaks into cubes. Soft (H 2½), and melts in the rain, but used as amulets by several peoples. Taste will confirm identification.

24 Hematite (Haematite) Heavy (Sp. Gr. 5.3, twice that of quartz), hard (H 6), submetallic luster, dark but gives a red streak on the tile. An iron ore.

25 ** Jade The term covers two distinct minerals. True jade is jadeite, very tough, H 6½, translucent, greasy luster, but glassy when polished. The bright green is the most valued of its many shades. It is granular and tiny pits are visible with a lens on a polished piece.

Nephrite is related to tremolite (3.5.52), softer and finer textured than jadeite, but also tough and more often green. Artificial coloring and substitution of many minerals for jade are ancient practices.

26 ** Lapis Lazuli A rock, primarily the blue gem lazurite, which is dull, greasy, deep colored, H 5-5½: Calcite lightens the blue and is the white matrix, and pyrite forms tiny golden specks in the rock.

27 ** Limestone A sedimentary rock with a majority of carbonates. Usually light in color and weight, and soft, but it can be dark, hard, and take a high polish. A drop of HCl will effervesce slowly. The presence of fossils, often tiny, is an important clue.

28 Limonite Hydrated hematite (3.5.24), heavy, dark, H 5½, streak yellow-brown. Forms crystals after pyrite.

29 Malachite Strikingly banded green, opaque except where thin, H 3½-4. A copper ore.

30 Marble Metamorphosed limestone of many colors, well known in polished form on public buildings. H 3.

31 Marcasite Best known on costume jewelry. Pale brass yellow, metallic luster, tarnishes grey-green, H 6-6½. Distinguished from pyrite by bright yellow streak.

32 Meerschaum A compact white clay (sepiolite) found principally at Eskisher, Turkey. Soft, floats in water.

33 Mica Thin, elastic, pearly luster, translucent sheet, breaks easily, H 2½.
34 Obsidian Natural volcanic glass, similar to man-made, H 5½. When thin is translucent with wisps of grey or red colors.
35 Ocher (Ochre) Weathered hematite or limonite, chalky red or yellow, H 1. Used for body painting.
36 Olivine Translucent, glassy, green (peridot) or yellow, color is even, H 6. Also called chrysolite.
37 Porphyry Cemented rock with ingrown crystals which sometimes form patterns.
38 Pyrite Fools' gold is unlike gold: lighter, harder (6-6½), sparks when hit with iron, streaks black on the tile. Cubic crystals were often merely perforated; crystal sides are striated.
39 Realgar Transparent dark red when fresh, exposure imparts a powdery orange coat. Orange-red streak, H 1½-2.
40 Rhodonite Translucent to opaque rose-red, glassy luster, pearly on fracture, H 6.
41 Sandstone Cemented sand, many grain sizes, colors, sometimes crumbly. Grains have H 7.
42 Schist Metamorphic layered rock, large mica grains. Usually rough-textured, but fine-grained used for beads.
43 ** Serpentine Translucent to opaque, usually green. H 2½-5, tends toward the lower. Waxy or greasy luster, even feels greasy. Tough, fibrous, greenish boentite substituted for jade. Ophite is alternate term.
44 Slate Fine-grained, dark metamorphosed clay, H 3-4. Plate-like structure, used for pendants.
45 Sodalite Translucent deep blue, unevenly colored, greasy luster, H 6. Important in pre-contact S. America.
46 Spinel Deep red, H 8. Mainly from Sri Lanka, often tumbled and perforated, not shaped.
47 Staurolite Opaque/translucent brown, brittle. On conchoidal fracture alters to earthy luster, H 7+. Unmistakable as cross-like crystals, but be suspicious of perfectly formed crosses.
48 ** Steatite The unsung bead mineral hero, a form of talc. When fresh is white or light green and soft, H 1. It is carved and perforated, and then heated, driving out water and raising hardness to 5½-6½. Most fancily carved dull white, black, green, etc. beads are made of steatite. Also called soapstone.

49 Syenite Granite-like rock lacking quartz. Usually light in color.
50 Tektites Natural glass objects formed by meteorite impact. Many shapes; surface is pitted, not glassy.
51 Tourmaline Translucent, glassy, many colors, green and pink, especially, H 7½. Distinguished from other hard stones by concentric bands of color.
52 Tremolite Transparent light green, glassy, brittle, H 5-6. Called greenstone.
53 ** Turquoise Light blue, waxy luster, brittle, H 4-6. Plastic strengthing treatment considered acceptable, but there are many false practices: bits are cemented together and dyes are used. Butter or oil bleaches some dyes. Porous stones turn green by absorbing body oils. The naturally green variety is not highly valued.
54 Vivianite Transparent, H 1½-2. When fresh is colorless, darkening to blue, green, etc. Sold as turquoise.
55 Volcanic Tuff Light, porous ash, similar to basalt (3.5.4), sometimes floats in water (pumice).
56 Zeolite Opaque/translucent, white, splinters, H 4.

HARDNESS CHART For quick identification, test for hardness, then read the descriptions above.
Scratched by fingernail: Bauxite, Chalk, Graphite, Gypsum, Meerschaum, Ocher, Realgar, Vivianite.
About same as fingernail: Alabaster, Bauxite, Chlorite, Cinnabar, Epsomite, Halite, Mica.
Scratches fingernail: Calcite, Marble, Mica, Serpentine.
Scratches penny: Apatite, Dolomite, Fluorite, Malachite, Serpentine, Turquoise, Zeolite.
Scratches knife: Obsidian, Tektite, Tremolite, Turquoise, Steatite (hardened).
Scratches glass: Feldspar, Goethite, Lazurite, Marcasite, Olivine, Pyrite, Rhodonite, Sodalite, Steatite (hardened)
Same as file: Chalcedony, Hematite, Jasper.
Scratches file: Beryl, Corundum, Garnet, Quartz, Spinel, Staurolite, Tourmaline.
ROCKS (Compound structures): Basalt, Breccia, Granite, Lapis Lazuli, Limestone, Porphyry, Sandstone, Schist, Slate, Syenite.

Section Four:

O R G A N I C M A T E R I A L S

4.1 BACKGROUND The earliest beads were made from plant and animal parts whose shapes, textures, and colors caught the eyes of ancient men and women. Many organic materials are of low ornamental status, and we lack much information on seeds, wood, shells, etc. as beads. But organic materials also include ivory, amber, and pearls, which are valued and have been extensively studied.

A seed or piece of shell is often too meager for specific identification, even by experts. If we despair of knowing each species of every bead we are consoled by their sheer beauty and their almost magical stories.

The hot point (1.3), brine floatation (1.8), HCl (1.9), and keen eyesight are most important here.

4.2 AMBER A fossil resin some 50,000,000 years old, usually identified as sap from the pine tree Pinus succinifera. The world's largest deposit is near the Baltic Sea. This amber is called succinite, as it has succinic acid, perhaps due to repeated weathering. Many other varieties are known; the Dominican Republic and Burma are the next most important sources.

Amber's properties result from fossilization. Long burial drove off volatile constituents, and the remainder underwent polymerization, making it stable with a high melting point. Amber that sat in the sun when fresh had gas bubbles driven out of it and is clear. Otherwise it remained cloudy. Internationally, the price of these two types is the same; locally one is usually preferred.

Insects and other small animals trapped in the fresh resin got buried. Their bodies disintegrated, leaving a cavity stained with organic matter which preserves fine details. Perfect fossil specimens are rare (and can be faked), but bits of organic matter— tree scales, legs, wings, etc.— are not too uncommon.

Amber has been a prized bead material since trade began in the European Middle Stone Age. It is one of the most imitated materials, easily confused with ambroid, (below), copal (4.5), and plastics (5).

T E S T S: Amber Warm to the touch, soft on teeth, light in weight, H 2-3. With the hot point it does not melt and gives off a pine smell (do not inhale deeply; succinic acid can irritate the throat). It usually will float in the 2 tbs. and 4 tbs. brine solution (some plastics float in water; most will not float in 4 tbs. brine). It is electrically charged when rubbed and picks up bits of paper, but so do some plastics. Amber chips (jab near the perforation); plastics will not, but some other resins do.

Abroid passes all these tests, but has distinct clear and cloudy layers. It is pressed from scrap bits of amber and usually sells for as much as natural amber.

Amber is fragile. Do not crush under other beads or subject it to temperture extremes. Clean with a mild hand soap and water.

* * *

4.3 BITUMEN Despite current low status, this was a wonder to the ancients. It was found naturally and used for fuel, waterproofing, adhesives for inlay, in black magic, and as amulets and beads for the poor.

Various names include: asphalt (Greek), the clay-filled unrefined product from the ground, pitch (Tartar) and bitumen (Sanskrit), both meaning fuel and used for the clean material, and tar and macadam, modern names for the synthetic by-product of the petroleum industry.

T E S T S: Bitumen Opaque black, soft on the teeth, warm to the touch, smells like tar in the hot point, will burn in a flame. Old beads are often brittle and fragile with cracked surfaces.

* * *

4.4 BONE One of the earliest bead materials, bones are used in several ways. Small bones-- knucklebones (metacarples, metatarsels), fish vertebrae, thin bird bones-- were merely perforated. (One wide-spread ancient practice was the pious wearing of the jaw or fingerbone of deceased relatives.)

Large bones were sectioned and perforations made of the marrow cavities. Flat bones (scalpulae and skulls) were made into flat pendants. Stag horn (bone, not horn) was commonly used in Japan for netsukes. Bones to be cut were not boiled but aged a bit to prevent splitting.

T E S T S: Bone Fresh bone is dull white, somewhat bright against the teeth, warm to the touch, slightly effervesces with HCl, has no smell with a hot point, H 3. Along its length are short grooves, the Haversian blood vessel canals, forming dots on cross-section.

Long burial fossilizes (mineralizes) bone, making it darker, heavier, harder (H 5), and more effervescent with HCl.

* * *

4.5 COPAL and MYRRH These are natural but not fossil resins. The best copal is the semi-fossilized resin of *Trachylobium verrucosum* and other extinct trees from Zanzibar. True copal is scarce and nearly as expensive as amber. It is opaque yellow.

Myrrh is the resin of some 80 plants, most importantly *Balsamodendra myrra* Nees. and *Commiphora malmol* of north-east Africa. It exudes as drops and is pierced to make beads without further shaping.

T E S T S: Copal and Myrrh Copal resembles amber: it chips with a needle, floats in 2 tbs. brine, and smells like resin with the hot point. But it melts with the hot point or in boiling water. It turns sticky in alcohol, linseed oil, turpentine, or methalated ether.

Myrrh is brownish-yellow, crumbles easily, is soft and light, and smells like balsam in the hot point test.

* * *

4.6 CORAL Gem coral is a calcite support structure built by sea creatures, polyps. Some corals form reefs, but precious coral (*Corallium rubrum*-- *C. nobilis* is obsolete) grows in tree-like colonies 10 to 30 cm high (3 - 10"). The polyps cover the "skeleton" with a connective layer, the coenosarc (commonly called the bark when dried). The skeleton is pink to dark red and even white or black. Coral is fussy about its enviornment, needing 13° - 16° C., clear, still water, and a depth of 20 to 300 meters. Though species of precious coral grow in various situations and places, the optimal location is the Mediterranean.

Formerly coral was dredged with a heavy basket which broke it off and collected it, but now it is mostly dived

for. Other corals used for beads include the black horny Indian coral, Akbar or King's coral, *Antipathes spiralis*, and the blue akori coral of West Africa, *Allopora subviolacea*. Corals are also often dyed.

T E S T S: Coral Precious coral has a warm, dull color and easily breaks with a hackly surface, revealing concentric growth layers. It will effervesce with HCl, H 3 3/4. A hand lens shows fine striations, vertical growth lines, which separate around an attached branch. Polyps leave small depressions, sometimes touching and sometimes a cm or so apart. Striations and depressions may be removed with intensive polishing.

* * *

4.7 EGGSHELL Ostrich egg is thick (up to 2 mm) and flat (40 cm/16" long) enough to make into disc beads, an industry that began in India about 25,000 years ago. The shell is broken into circlets (sometimes with the teeth), pierced, strung on a stick or cord, and rubbed along a stone, which smooths and polishes them and makes them all of uniform thickness.

Perhaps the most unusual material ever used for beads is dinosaur eggshell, made into disc beads in the Gobi desert of China some 12,000 years ago.

T E S T S: Eggshell Easily chipped or broken, will effervesce in HCl, H 3. Ostrich eggs have small scattered brown patches, which weather to rough pits.

* * *

4.8 FOSSILS Whole fossils were among the earliest of beads; patterned ones were probably considered magical. Fossil snails, bivalves, shark's teeth, trilobites, crinoid stems, ammonites, urchins (whole and large spines), belemites, sponges, and the bones and teeth of many animals have been used for beads.

T E S T S: Fossils Fossils are either preserved remains, or, more commonly, casts of past life forms. They test according to the mineral which preserves them, limestone (3.5.27), sandstone (3.5.41), slate (3.5.44), silica (3.2), etc. Once you are sure you do not have a glass or plastic imitation, a fossil handbook or a specialist (paleontologist) can help.

* * *

4.9 IVORY Ivory is dentine, which covers our teeth, and which some mammals grow into large tusks. True ivory is from elephants (African or Indian; the former is considered superior). Other large animal teeth— hippo, walrus, sperm whale, narwhale, and dugong— are also considered ivory. "Fossil" ivory is not fossil, as it is not mineralized. It comes from mammoths buried in great numbers in Siberia; as late as 1929, a Soviet official avowed the supply was inexhaustible.

Ivory is one of the oldest bead materials, used up to 30,000 years ago. It was no doubt valued then, as today, and is probably the longest-lived high-status bead material. There are many imitations; simulated ivory was one of the first uses for plastic.

T E S T S: Ivory Soft, warm color, hard against the teeth, no effect from hot point, H 4. Elephant ivory has faint criss-cross lines (lines of Retzius) caused by diamond-shaped pores filled with a softer gelatinous substance. This has been imitated by Celluloid (5.6.4). Hippo ivory is harder than elephant and has close but not intersecting lines. Whale ivory has fine lines and is found only in small pieces. Walrus ivory is oval in section with coarser lines and a mottled interior. "Fossil" ivory is grey and preserves the crossed lines. When examining, turn the bead around to examine these structures properly. Ivory yellows with age.

Hornbill ivory is not ivory but the horny bone in the casque of Hornbill birds (Phinoplax sp.), and is yellowish with red on top and sides. Vegetable ivories (see index) have dotted or small oval structures.

Ivory can be cleaned with turpentine and set in the sun; this will also bleach out the yellow patina.

* * *

4.10 JET Another fossil used for beads since antiquity, it is the hardest and shiniest coal, called bright coal or vitrain. It is probably composed of wood (antharxylon) of branches and twigs, while other coal is made from soft plant parts. It is very black and takes a high polish.

"Soft jet" may have formed under fresh water rather than salt. Lignite, channel coal, durain, and other coals are often confused with jet now as in the past. All of these craze and disintegrate more than true jet. The main jet sources historically have been Whitby, England, Erzurum, Turkey, and the Galacia region of Spain.

T E S T S: Jet Soft, warm, and light in weight, jet breaks with a conchoidal fracture, gives a brown streak on the tile, may be homogeneous or show wood grain, H 2-2½. The hot point or hard rubbing gives a coal smell. Rubbing jet produces static electricity, helping to give it the name "black amber." Plastic superficially resembles jet; "French jet" is glass. Distinguishing jet from some other coals is very difficult. It may be cleaned with a soft cloth and polished with a bit of oil.

* * *

4.11 KERATIN PRODUCTS An animal protein present in the skin, keratin produces hard protective parts such as hair and nails on humans. It is soft but tough. Many keratin products are attractive (feathers, quills, scales), and others recall brute strength (claws, horns, bills). Some are prosaic (hooves), and others extremely expensive (rhino horn). "Tortoise shell" is a misnomer. Turtles (Chelone imbriacata, Eretmochelys imbriacata) supply the scales used for ornament, not tortoises.

Keratin does not survive burial well, and our record of their use in the past is scanty, but we assume they were widely used, as they are today. Many keratin beads retain their original shape and color, while others are cut apart and dyed or bleached.

T E S T S: Keratin Products Your fingernails are of keratin and display all the characteristics: soft (H 2½), tough, grows in fibers, and can peel or chip in layers. With the hotpoint keratin smells like burning hair/wool. The dark patches on "tortoise shell" will resolve into many points like a half-tone picture under a lens. These beads may be polished with a little linseed oil.

* * *

4.12 LAC and LACQUER These are two different substances.

Lacquer from China and Japan is made from the sap of a sumac, Rhus vernicifera. It is usually painted on a wooden base, but may be built up in layers into blocks (the Japanese make multi-colored blocks) and cut into beads. The traditional red turns black with age.

Lac (India, etc.) is secreted by the female of an insect (Laccifera lacca and others), who exudes a coat around her body with only a hole for life processes, sucking in resin from any one of several trees. The females swarm in great numbers, giving rise to the Indian number lakh, which first meant a great multitude, and is now 100,000 (always written 1,00,000). Lac is gathered, boiled down for shellac or stick lac, and the latter used for beads, often decorated with tiny mirrors and other inlaid objects. The body of the insect provides the common red dye used to color lac.

T E S T S: Lac and Lacquer Lacquer is light, warm, dull on the teeth, and a pin will scratch but not chip it. It does not react to the hot point test.

Lac is also light, warm, and dull, but a pin will chip it, and it will melt with a hot point.

* * *

4.13 PEARLS Virtually every shelled mollusc is able to produce a pearl to protect itself from a bit of foreign matter. However, only a few species produce gem pearls, the most important being the marine oyster Pincata margaritifera, and the freshwater clams Unio verreauxi and Margaritura margaritifera. The animals cover the irritating matter with layers of shell material, beginning with dull layers and ending with iridescent nacre.

There are natural pearls (oriental) and man-induced (cultured). The Chinese cultured freshwater pearls for centuries, but Kokichi Mikimoto of Japan was the first successful cultivator of the pearl oyster in the 1890s. Prices then plunged, but have since risen; today cultured pearls are nearly as expensive as natural ones. Telling the difference is beyond the layman's reach.

The finest Japanese freshwater pearls are called "biwi pearls," tiny ones are called seed pearls, and misshapen ones are baroque pearls. After 100 to 150 years pearls loose their luster ("go blind") from exposure to air, body chemicals, and friction.

Pearls have been so long prized that the word for bead in many languages (e.g. French, German, Italian) comes from pearl. They have been widely imitated. Cut nacre, alabaster soaked in oil or wax, coated glass, glass treated with fluoric acid, and plastic are some of the imitating substances. The best imitation is made by

coating the inside of blown glass beads with essence d'orient (guanine, a mucus from the base of the scales Alburnus lucidus and other fish), then filling the bead with wax. Spanish Majorca pearls are made this way.

Other important pearl producers include: Marine--Haliotis sp., Meleagrina margaritifera, Mytilus smaragdinus (green pearls), Pinna noblis, Placuna placenta, Strombus gigas (pink), and Tridacna sp. Freshwater--Dipsus plicatus and Lamellaidens marginalis.

T E S T S: Pearls Pearls are soft, light, and have a characteristic sheen. Close examination reveals layers of nacre (mother-of-pearl), H 3 3/4. Rubbed against the bottom of front teeth, pearls feel gritty; glass and plastic feel smooth. To clean, boil bran with a pinch of alum and cream of tartar, and let cool. While the water is still warm, soak the pearls, rubbing softly in the hands. Set on clean paper in the dark to dry.

* * *

4.14 SEEDS and PLANT PARTS Seeds were probably the first bead material, and they are still widely used today. Unfortunately, they are low in status, often difficult to identify, and do not preserve well. Our knowledge of them as beads is less than complete.

Most seeds are used whole as beads; others are cut from large seeds. Identifying a plant from the seed alone is very difficult. This list of seeds (and other plant parts; wood is treated in 4.17) used for beads is accompanied by brief notes. Those marked ** are illustrated in Plate 1.

1 ** Abrus precatorius L. Small, bright red with a black end. Coral seed, crab's eye, etc.; the Latin name notes its use for rosaries. Slightly poisonous, sometimes employed in black magic.

2 ** Acacia sp. Ancient Egyptian girls wore the pods and beads imitating them; seeds worn in India.

3 Achyranthes aspera L. Root worn in tribal India to aid in labor.

4 Adenanthera pavonina L. Small, flat, round, brown seeds used for necklaces and rosaries.

5 Adina cordifolia (Roxb.) Benth. & Hook. Leaves worn by Birhors, India, as ornaments.

6 Aegle marmelos Corr. Seed of the Bengal quince.

7 Allium cepa L. Onion, worn for protection.

8 Allium sativum L. Garlic; repels vampires.
9 ** Areca catechu L. Betal nut; carved for beads.
10 ** Azadirachta indica A. Juss. Long, three-sided white seed of the medically useful Neem tree.
11 ** Caesalpinia crista L. Hard, shiny, flat oval seed worn on rosaries and to prevent abortions.
12 ** Canna orientalis Rosc. Indian shot, "raisin seed" Small, rough black oblates often used on rosaries.
13 Cannabis sativa L. Resin rolled into beads, Morocco.
14 Cardiospermum halicacabum L. Grass seed, Formosa.
15 Caryota urens L. Sago palm, India, nut pulp used for vegetable ivory.
16 Celtis reticulata Hook. f. & Th. Hackberry seeds, southwest native Americans.
17 Cicer arietinum L. The chick-pea or garbanzo.
18 ** Cocos nucifera L. The coconut; shells cut into disc beads, Africa and Oceania.
19 ** Coix lachryma-jobi L. Job's tears, the most widely used seed bead. The top is naturally open, the bottom easy to grind down. Usually drop-shaped (also oblate and cylindrical), when cultivated as a cereal it looses its hard, shiny coat, so must be gathered in the wild for use as a bead. Native to south-east Asia, it has been introduced and re-introduced to Europe, America, and Africa. Now used world-wide.
20 Corypha umbraculifera L. Palm nut for vegetable ivory.
21 Curcuma longa L. Tumeric; root strung for luck, India.
22 Dalbergia sissoo Roxb. Seeds worn in ears by Santel girls (a tribe in India).
23 ** Elaeocarpus ganitrus Roxb. (= E. sphaericus), E. lanceaefolis Roxb., ** E. tuberculatus Roxb. Large, red-brown rough seeds called Rudraksha in India, holy to Shiva. Some are ellipsoids, but most are globular and divided into facets, usually five. Single facets and multiple ones up to 11 are rare and costly.
24 Elettaria cardamomum Maton Aromatic cardomum seeds.
25 Emblica officinalis Gaertn. The amalaka fruit is not very suitable for beads, but Indian authorities believe it was the model for the gadrooned oblate beads known in the West as melon beads.
26 Ephedra sp. Seeds worn by southwest native Americans.
27 Erythrina variegata L. Another coral seed; bright red.
28 ** Eugenia caryophyllata Bull. & Harr. (= Caryophyllus aromaticus L. The clove, a dried flower worn from Zanzibar to Iran, especially among Arabs.

29 Euonymus grandiflorus, E. fimbriates, E. lacerus Bush & Ham., E. tingens Wall. Red tree seeds, Himalayas.
30 Ficus lanceolata Bush & Ham. Aerial root worn by natives of the Andaman Islands.
31 Ficus racemosa L. Pods worn on the eighth day of confinement, India.
32 Ficus religiosa L. Leaves of the holy Bo or Pipal.
33 Gardenia turgida Roxb. Roots worn in Chota Nagpur, India, by tribal people.
34 Gyrocarpus americanus Jacq. American import to India; winged seeds used at festivals.
35 Hemidesmus indicus R. Br. Roots worn, Bastar, India.
36 Hordeum vulgare L. Barley; woven into animal and house decorations, Iran.
37 ** Hyphaena thebaica Vegetable ivory, Africa.
38 Ipomoea pes-caprae Sw. Hyacinth seeds.
39 Juglans regia L. Walnuts; often carved in China, worn by Aztecs, etc.
40 Juniperus sp. Juniper seeds, popular on West Coast with native Americans.
41 Leucaena lecocephala Lam. Fruit worn, India, America.
42 Melia azedrach L. Chinaberry, Persian lilac, Bead tree; white, fluted, oval seeds, necklaces and rosaries, popular world-wide; put on doors to prevent smallpox.
43 Mimusops elengi L.
44 Mirabilis jalapa L. Rough black Four O'Clock seeds.
45 Murraya koenigii Spreng. Seeds worn by Chenchu tribe, India.
46 Musa paradisiaca L. The banana or plantain; seeds worn in Africa and India.
47 Nannorhops ritchieana H. Wendl. Rosaries, India.
48 Nelumbo nucifera Gaertn. The lotus; seeds and pod (torus) worn in ancient Egypt, modern India.
49 Olea europaea L. Olive seeds.
50 Oroxylum indicum Vent. Winged seeds, India.
51 Pandanus tectorius Soland. Leaves worn, India.
52 Phoenix dactylifera L. Pits of the date palm.
53 ** Phragmites sp. Reeds; dyed, strung, eastern India.
54 Phytelephas macrocarpa Ruiz. & Pav. Tagua or Corozo nut; vegetable ivory from Latin America.
55 Pinus sabiniana. Pine seeds; west coast native Americans.
56 Plumbago zeylanica L. Root strung to relieve pain, Bastar, India. The plant is, in fact, medicinal.

57 Prunus cerasoides D.Don. Pit of a wild cherry; rosaries and necklaces.

58 Prunus mahaleb L. Highly scented pit.

59 Prunus persica Batsch Peach stone; cut into fancy beads, China and Japan (for ojime).

60 ** Putranjiva roxburghii Wall. Round tan seeds; generic names means "life of the son (child)." Used to protect children from diseases, India.

61 Quassia indica Noot. Seeds protect children from asthma, India.

62 Quercus sp. Acorn; seeds and caps worn by native Americans, southwest.

63 Rhizophora sp. Seeds of bearded mangrove, Barbados.

64 ** Ricinus communis L. Castor seed; India and Iran.

65 Rosa sp. Rose petals crushed together to make beads.

66 Scleria racemosa Sedge seeds, worn in long strands in late Stone Age, East Africa.

67 Sesamum sp. Sesame seeds, worn in Cameroons, Africa.

68 Stereospermum suaveolens D.C. Seeds worn for eye disease, Bastar district, India.

69 Sycopsis kotoensis Saski. Tree seeds worn in Formosa.

70 Symplocos laurina Wall. Jug-shaped seeds, rosaries and child protection, India.

71 Terminalia tomentosa W. & A. Leaves recorded as the only clothes of the Juangs, a tribe in India, when first met by outsiders.

72 Thevetia peruviana Schum. An American import, seeds worn in India.

73 ** Trapa sp. Water chestnut; beads and spindle whorls in Iran.

74 Vitis vinifera L. The grape; seeds on dolls in the Cameroons; raisins strung for curtains, western India.

75 Xeromphis spinisa Keay. Fruit put on wedding couple during marriage ceremony, India.

76 Zea mays L. Corn tassels, worn in the Cameroons.

77 ** Zizyphus jujuba Lam. Seeds of the jujube fruit.

78 Zizyphus xylopyrus Willd. Jug-shaped ghata nut; worn by Koli tribe, India, to protect children.

4.15 SHELL Shells are produced by animals of two phyla: Brachyopoa and Mollusca. Brachyopods have two shells which are bilaterally symmetrical (e.g. cockles). Molluscs are very numerous and may have no shell (octopus), an interior shell (squids), one exterior shell (snails,

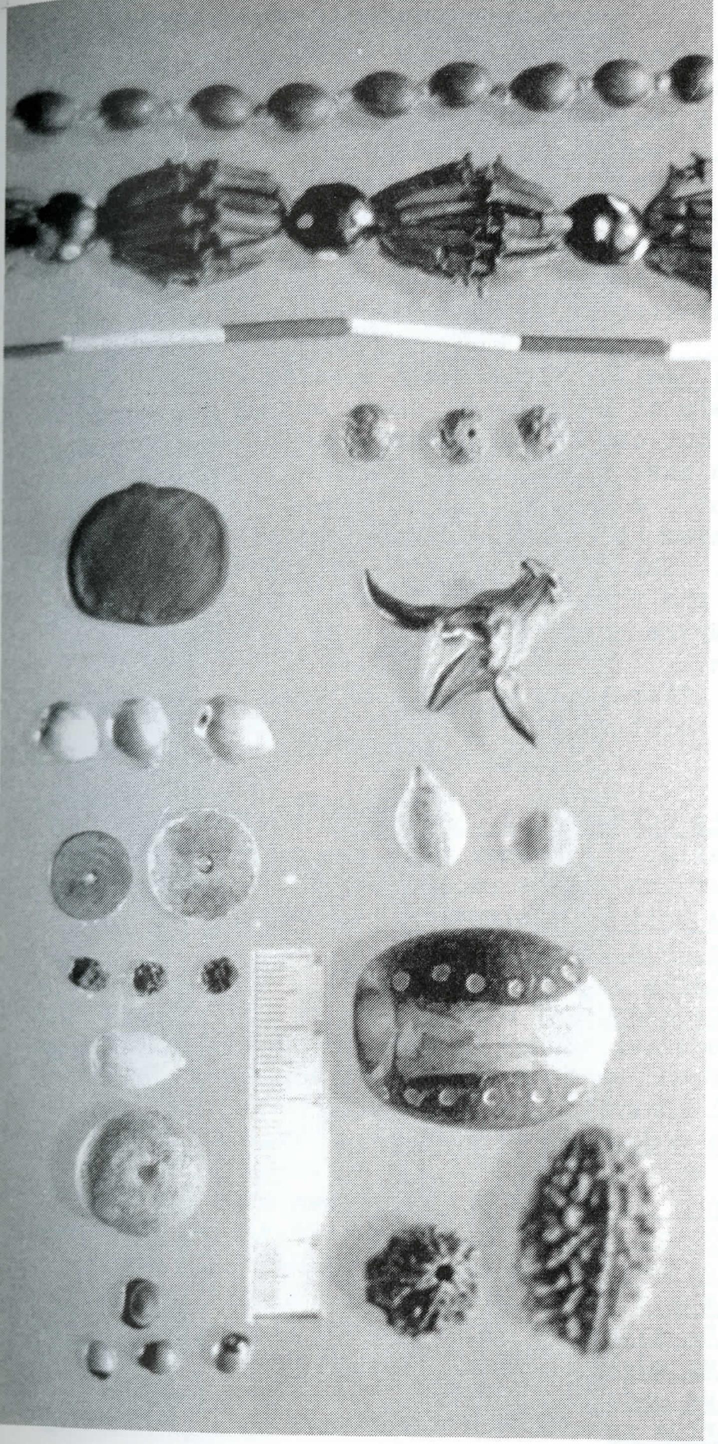

PLATE ONE - SOME SEEDS USED FOR BEADS

Left to Right: Top Row: Abrus precatorius, Acacia sp., Azadirachta indica, Canna orientalis, Cocos nucifera discs, Coix lachryma-jobi, Caesalpinia crista. Bottom Row: Elaeocarpus ganitrus, & E. tuberculatus, Hyphaena thebaica, Putranjiva roxburghii, Trapa sp., Zizyphus jujuba. Strands: Phragmites sp., Eugenia caryophyllata (with glass beads), Ricinus communis.

Photo by Johnny Parisi

nautilus, dentalia), two shells (clams, oysters), or more than two (chitons have six).

Some of the earliest beads were of shell, especially the dentalia, which need no piercing, and shells that are easily pierced. Later, large shells were used as raw material to be cut into beads. Some shells are cut and are still recognizable, such as conus tops and cowries with the backs cut off. Those marked ** in the following list are illustrated in Plate 2.

T E S T S: Shell Whole shell species can be identified with the help of a handbook; those cut up are more difficult, but can be recognized from other materials.

Shells have an outer layer (the hyperostracum, sometimes absent), a middle layer (the ostracum), and an interior layer (the periostracum, which forms nacre when irregular). The middle layer is skewed at an angle to the others and three (or two if the hyperostracum is missing) layers running in different directions are easily seen.

Shell effervesces with HCl slightly. No reaction to the hot point, H 4-5.

* * *

1 Achatia balteata, A. monetaria Large freshwater African snails, the former from the coast, the other inland. Cut into discs resembling ostrich eggshell (4.7).

2 Acmaea patina A limpet, used whole.

3 Adamus mendicardium

4 Ancillaria sp.

5 ** Arca grandosa Giant clam cut into "hippo teeth" and other special shapes in West Africa. Some of these beads are found east as far as Afghanistan. Used for white shell money in the Solomon Islands.

6 Asraea undosus Large nacrous bivalve, cut by native Americans, west coast.

7 Buccinum undatum Welk, sometimes used for wampum.

8 Busycon perversum Welk, sometimes used for wampum.

9 Calliostoma annulatum Small snail used whole.

10 Callista chione Marine "Venus clam."

11 Cardita antiquata Ribbed marine clam, used whole

12 Cardium edule A cockle, used whole.

13 Cassius nodulosa

14 Catharius sp. Marine snail used as a pendant by

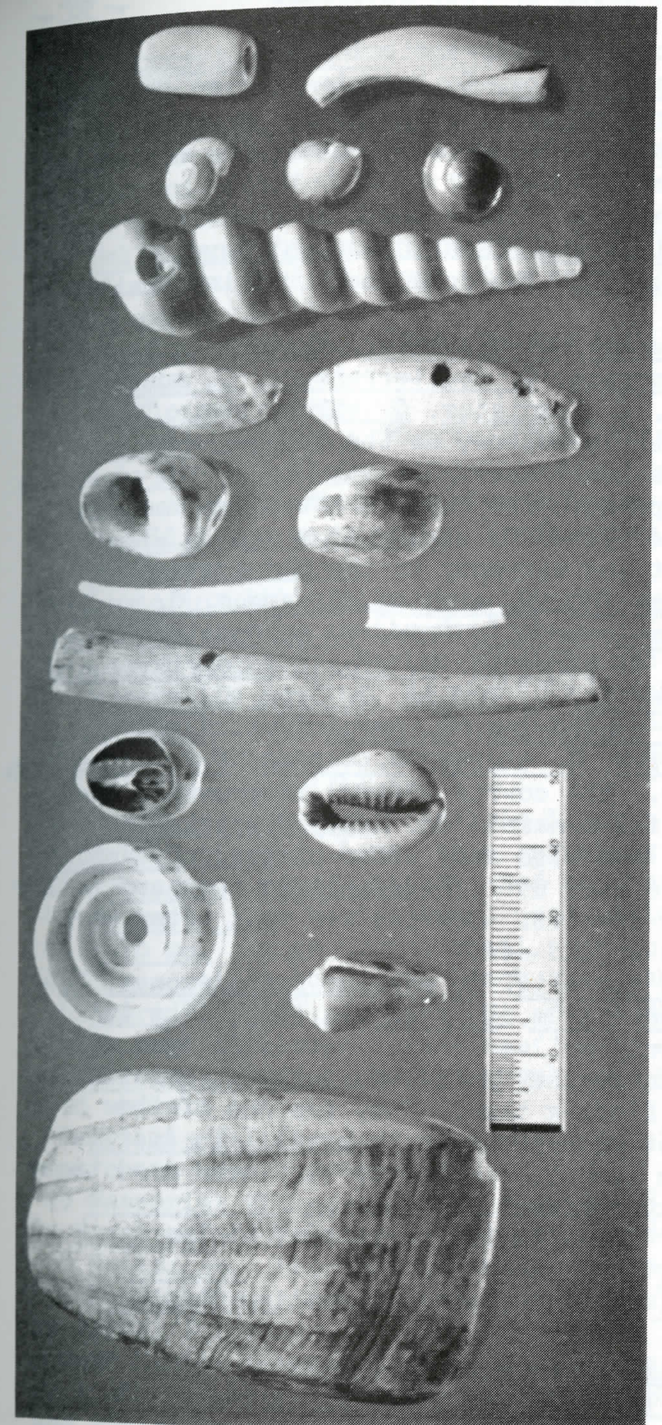

PLATE TWO - SOME SHELLS USED FOR BEADS
Left to Right: Arca grandosa "hippo tooth," Conus sp. (top and whole), Cypraea (two views), two species of Dentalium, Nerita sp., Oliva sp., Umbonium sp., Xanthus pyrum bead & bangle.
Photo by Johnny Parisi

crushing spire to remove it, ancient India.

15 Cerithidea californica, C. sacrata Marine snails used whole, the second by Aztecs.

16 Chama pacifica Large marine bivalve; the red shell money of the Solomon Islands.

17 Clanculus pharonis Marine snail used whole.

18 Cleopatra bulimoides Used in ancient Egypt.

19 Columbella rustica The dove shell, marine snail used whole.

20 ** Conus betulina, C. gladiator, C. imperialis, C. literata, C. marmorata, C. mediterraneous, C. musicus, C. papolionaceas, C. teaniatus, C. virgo, etc. The popular cone shell is hollow, as the columella is absorbed by the animal, making it easy to string when the apex (umbo) is opened. The base is often removed, and the top part (the spire) is strung as a disc. Widely used for ornament and currency in the Old and New Worlds.

21 ** Cypraea annulus, C. arabica, C. argus, C. asellus, C. aurora, C. camelopardalis (syn. C. melenostoma), C. caput-serpentis, C. carneola, C. erosa, C. erythraensis, C. helva, C. isabella, C. lurida, C. lynx, C. moneta, C. occellata, C. pantherina, C. pyrum (syn. C. rufa), C. spedicea, C. spurka, C. tigris, C. turdas, C. ventriculus, C. vitellus, etc. The cowrie (cowry) is probably the most used shell for ornament and money, especially in Africa and Asia, but also many other places. C. annulus and C. moneta are most used; some believe they are really varieties of one species. Cowries are most often worn with their backs ground off.

22 ** Dentalium dentalis, D. entale, D. hexagonum, D. javanum, D. octangulatum, D. vulgaris, etc. The tusk shells are the only mollusc shells naturally open at both ends of a tube; they make beads without any work expended beyond finding them. They are one of the earliest and most widespread shell beads. In America they were status symbols; in Europe they were used tens of thousands of years ago.

23 Drillia sp. Small marine snail used whole.

24 Echinoid sp.

25 Ellobium sp. Marine snails resembling Oliva and similarly used.

26 Engina mendicaria Small, bright Asian marine snail.

27 Fasciolaria sp. The tulip shell, marine snail.

28 Glycymeris maculata, G. vislacescens Marine bivalve used whole by native Americans.

29 Haliotis californiensis, H. cracherodii, H. rufescens The abalone, cut into beads by native Americans. The first species listed has a pink back, the second is green, and the third red.

30 Helix desertorium, H. pomatia Land snails, the first used in ancient Egypt, the second is the common edible garden snail.

31 Hinnites gigantia Large marine bivalve, hinge cut into beads.

32 Homalopoma sanguinea

33 Kelletia kelletia Marine snail, columella used.

34 Laevicardium elatum Giant cockle, used in ancient Europe. In prehistoric America Hohokums etched them.

35 Lamellaidens marginalis Fresh water pearl mussel.

36 Lissoccatoides sp.

37 Littorina littoralis, L. littorea, L. planaxis The periwinkle, marine snails used whole.

38 Lottia gigantea Marine bivalve used whole.

39 Marginella apocium, M. glabella Small colorful margin shells. Tops were ground off these marine snails by native Americans in Virginia. In England they were called "Blackmoors' teeth."

40 Megathura crenulata Keyhole limpet, used whole.

41 Melanopsis sp. Long, thin spiraling marine snail.

42 Meleagrina margaritifera Red sea pearl clam.

43 Meliacus sp. Marine snail used whole.

44 Melo sp. Large marine snail, cut up for beads.

45 Mercenaria mercenaria Black clam used for wampum.

46 Mitra literata, M. maculosa Miter shells, marine snails used whole.

47 Murex ternispina Marine purple-dye yielding snail, used whole.

48 Mytilus californians Columella cut into beads, west coast native Americans.

49 Nassarius gibbosulius, N. mendica, N. reticulatus (= Nassa sp., obsolete) Marine snails used whole.

50 Natica sp. Moon snails, marine, used whole.

51 Nautilus sp. Large marine snail, cut into pendants by tribal Formosans.

52 ** Nerita chamaelon, N. crassilabrum, N. crespiularia, N. litoralis, N. polita, etc. The slipper shell, widely and anciently used marine snail.

53 Neritina sp. Small Nerita-like snail, used whole.
54 ** Oliva bulbosa, O. nebulosa, etc. The olive shell is hollow as the animal absorbs the columella, making it easy to string after opening the apex. Used widely in both hemispheres.
55 Olivella biplicata, O. volutella Similar to Oliva, widely used by native Americans in California.
56 Ornamentarium annulus (= Cypraea annulus)
57 Osilins tubiformis
58 Ovula ovum, O. verrucosm Cowrie-like shells, used whole, especially in America.
59 Pachydesma stutorum Large marine clam cut into beads.
60 Patella vulgata The common limpet, a single cone easily perforated at the top.
61 Pectin aequisculcatus, etc. Scallops; among the first beads of China, 12,000 years ago.
62 Pectunculus violacescens Rome and prehistoric Egypt.
63 Phalium saburon Marine bonnet shell, used whole.
64 Pincatada fimbriata, P. margaritifera, P. galtsoff Pearl oysters. To stay in business pearl divers must also market the mother-of-pearl they gather.
65 Pirenella plicata Used whole, also as fossil.
66 Pleuroploca gigantea Florida horse conch, cut up.
67 Polinices mammilla Marine moon snail, used whole in prehistoric Egypt.
68 Pomatius oliveria Land snail used whole.
69 Potamides cingulatis Horn snail, marine mud-dweller.
70 Psuedomelatomides toroso Marine snail used whole
71 Ptychopotamides papavarceus Used fresh and as fossil.
72 Purpura lapillis (= Nucella sp. = Thais sp.) Marine snail, yields purple dye. Used whole, columella cut up.
73 Pusiostma mendicaria
74 Pyrula carica, P. canalicuarum Periwinkles, sometimes used for wampum.
75 Saxadomus aratus, S. gracilis, S. nuttali Marine clams cut into beads.
76 Spondylus americanus, S. gaederpus, etc. Thorny oyster (not a true oyster) lives in deep water and has a bright red spiny shell. Greatly valued whole and cut up in Bronze Age Europe, pre-contact America, and Oceania for money and status symbols.
77 Strombus gigas, S. mauriticancis A conch with differently colored layers, used for cameos.
78 Terebra consobrina Auger shell, marine, used whole.

79 Tivela crassalelloides Marine clam cut into discs by native Americans.
80 Tridacna gigas Giant clam from African waters, cut into tubes and ellipsoid beads.
81 Trivia californica Resembles cowries, used whole.
82 Turbo solandri, etc. Turban shell, used whole, cut into ojime in Japan. Operculum also used.
83 ** Turritella communis, etc. Long graceful marine snail widely used for pendants; Siberia (fossil), Europe, America, India, etc.
84 Tympanotonus margaritaceus Cerith shell, marine snail, fossil also used.
85 ** Umbonium sp. Indian button shell, a small colorful snail used whole.
86 Unio sp. Fresh water pearl clam. Used as ostrich egg imitation in Africa, whole in India, for wampum in America, etc.
87 Venericardia seleata Cockle-like marine bivalve used whole.
88 Venus mercenaria Quahog clam (Cherry stone), the main wampum source, also used whole.
89 Vermelus Not a true mollusc, but a marine worm. Straight tubes cut into beads by native Americans.
90 ** Xanthus pyrum The holy conch (chank, sank) of India, used as a trumpet, cut into bangles, and the columella used for beads.

4.16 TEETH Large teeth are considered ivory (4.9) Small teeth, along with bone and shell, are the oldest surviving bead materials in Asia and Europe. Some are quite special: deer canine in the European Late Old Stone Age, boar's tusks as a sign of bravery in Africa, human teeth necklaces from the Gilbert Islands, and a necklace of Tasmanian Devil's teeth from prehistoric Australia.

Teeth were an especial favorite in prehistoric times strung with a perforation or a groove. A Late Old Stone Age (Upper Paleolithic) site in Germany, Petersfels, had pendants of the teeth of eight animals: bear, lion, fox, wolf, lynx, deer, boar, and horse.

T E S T S: Teeth Teeth test like ivory: sharp against your teeth, no effect from the hot point or HCl. H 4. Species identification must be done by an expert.

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4.17 WOOD Abundant and fairly easily worked, wood has been widely used for beads. Some uncovered from Mainz-Linsenberg, Germany, 20,000 years old are surprising for surviving so long. Wooden beads are still with us, and are important segments of the bead industries of several countries including Germany, India, and Czechoslovakia.

T E S T S: Wood Identifying the species of wood from a bead is very difficult, but it is easy to distinguish wood from other materials. Look for grains under the lens and smell for wood in the hot-point test. Be sure you are testing the core, as wood is often painted, shellaced, varnished, etc.

* * *

1 Acacia catechu Willd., A. pennata Willd. Tough wood of a hardy thorn tree.
2 Adenanthera pavonina L. A coral or redwood tree.
3 Adhathoda vasida Nees.
4 Aegle marmelos Corr.
5 Aeschynomene aspera L., A. indica L. White, very soft and light sola pith used for hats and ornaments. The first is true sola, the other is softer and cheaper.
6 Alangium salviifolium Wang. (L. f.)
7 Aquilaria agallocha Roxb. Eagle wood. The rotting interior is aloe, highly valued for its scent.
8 Bambusa sp. There are over 550 species of bamboo, technically a grass; often sectioned into beads.
9 Brassica sp. Sticks of the mustard plant are worn in India.
10 Buxus sempervirens L. Boxwood; the name means "always strong," and it is. Elaborately carved rosary beads in Medieval Europe were often made of boxwood.
11 Cajanus cajun (L.) Millsp. Sticks of millet for amulets, India.
12 Capparis trifoliata
13 Dalbergia sisso Roxb. Indian rosewood, red in color, strong and scented.
14 Diospyrus virginiana L., D. texana Two ebonies, the first is persimmon, the second is "olive wood."
15 Flacourtia indica Merr.
16 Linum usitatissimum L. Flax stems strung and worn, India.
17 Madhuca indica J.F. Gmel. Licorice wood.
18 Michelia champaca

19 Ocimum basilicum L., O. sanctum L. Sweet and holy basil, worn by Vishnu worshipers in India.
20 Olea europaea L. The wood of the olive tree.
21 Pyrus communis L. Pear, a strong wood.
22 Quercus sp. Oak, recorded from prehistoric southwest native Americans.
23 Santalum album L. Sandalwood: white, highly scented, very expensive. Sawdust also pressed into beads.
24 Tamarix aphylla (L.) Karst. Tamarisk tree.
25 Taxus baccata L. A yew, twigs worn by Nagas of India to prevent pregnancy.
26 Zanthoxylum limonella (Dennst.) Alston. A satinwood.

4.18 MINOR BEAD MATERIALS There are a few other organic materials with limited use for beads. They are without literature, have played but minor roles in the bead story, and are often heavily altered from their original form. It is possible some of these have been more important than has been thought. As always, I would appreciate learning more.

1 Animal Parts The brightly colored backs of some beetles (usually the Meloidae family) have been strung as beads in India and Africa. Sea urchins (Echinus) have been worn, as well as large urchin spines. Snake skin has ornamented large dentalia shells in the Pacific north-west. (also Leather)

2 Camphor The scented gum from Cinnamomum camphora, Dryobalanopsis camphora, Laurus camphora, and also from coal tar, is camphor. This was pressed into beads for wedding garlands in Puri, Orissa, India, until 20 years ago, when the cost became prohibitive. On a hot wedding night the garland lasted no longer than four hours; this may be the most ephemeral of all beads.

3 Cartonnage The material from which many mummy cases were made was also fashioned into amulets in ancient Egypt. It is composed of many glued layers of linen or papyrus, often covered with stucco.

4 Cloth Indians and Pakistanis wind cloth with string to make beads. When at Mt. Athos I found a cloth rosary dropped by a monk, made by knotting yarn, no doubt manufactured in Greece. (also Cartonnage)

5 Food Crackers and zweiback have been plasticized or shellaced in the U.S. as pendants. Macaroni is dyed and strung as beads in several Latin American countries.

6 Leather Aside from the occasional leather disc bead, leather charm cases as early as the XII dynasty in Egypt (ca. 1800 BC) are known; the same things are worn today from Morocco to India.

7 Mythical Materials Unicorn horns were reported worn by the Timucua, a native American tribe. In Mozambique after mermaids were caught men wore their bones on the wrist to prevent bleeding. You can't believe everything you read.

8 Paper Most utilized is papier mâché made of shredded, adhesed, and shellaced paper. India has an industry of this, but it is dying. Carton-pierre was made in much the same way and often backed with paper to imitate stone or bronze. Gentlewomen in Victorian England amused themselves by rolling up colored wallpaper into tube beads. (also Cartonnage)

9 Rubber Round beads in dark earth tones are highly regarded for prayer strands in Iran. They are made of some sort of rubber, likely a natural latex.

10 Wax Carved beeswax beads were made in the Far East. The ancient Egyptians gilt wax amulets. Women at home in western India made beads for curtains by perforating drops of wax and stringing them with raisins. Paraffin has replaced camphor for wedding garlands in Puri, India

PLEASE NOTE: Though accuracy has been aimed for, the author is a layman, scientific nomenclature is in flux, and many sources for the lists in this section are old. Under the circumstances, discrepancies are unavoidable.

Section Five:

P L A S T I C S

5.1 BACKGROUND Plastics, that is, artificial resins, are the most ignored of bead materials for several reasons. They are new, they are complex (there are over 40 families of commercially important plastics), and there is a distinct prejudice against them, especially in developed countries.

With the study of beads as difficult as it is, it is no wonder that many collectors simply ignore plastic beads. There are, after all, enough beads of other materials to collect. But there is no such thing as an uncollectible bead, and plastics deserve more attention than they have received.

There is little non-technical literature on plastic and even less in print on plastic beads. The reader may excuse a somewhat longer introduction than has been given to other better known materials.

5.2 HISTORY OF PLASTICS Plastics were experimentally made in the 1830s, but in 1855 two Englishmen, Alexander Parkes and Daniel Spill, produced xylodine by dissolving cellulose (xylo- means wood) in nitric acid; this is cellulose nitrate. In 1865 Parkes made the first successful plastic by compressing xylodine and called it Parkesine. In 1868 Spill hardened xylodine with camphor to make Xylonite, a trade term still used in the U.K., the first commercial plastic.

In the same year the American Hyatt brothers, John Wesley and Isiah Smith, also developed a camphor hardened xylodine as a substitute for ivory in a contest held by a billard ball manufacturer. Patented in 1869 as Celluloid, it was marketed quicker than Xylonite, and was an immediate success, as it easily imitated many prized materials (amber, ivory, "tortoise shell"). However, it was dangerously flammable.

In 1885 Adolph Spitteler in Germany accidently produced casein plastic by treating casein (a protein found in milk-- caseus is Latin for cheese) with formaldehyde. It was first marketed as Galalith, "milk stone." Water absorption was its main drawback, neither could it be easily molded.

1909 marks the beginning of the modern plastics era when Leo Baekeland patented the product later named for him, Bakelite. This was more stable than Celluloid or casein, and is the only one of the three being made in any quantity today. Though first used as imitation amber, it is now mostly employed in electrical equipment.

Until after World War II all plastics were produced by a few industrial powers. Celluloid, imitating ivory, jet, mother-of-pearl, horn, "tortoise shell," amber, ebony, and agate, was concentrated (at 100 tons/day) in the U.S., Britain, France, Germany, Austria, Japan, and Switzerland. Half the Bakelite production of 60 tons/day in 1925 was made in the U.S., the other half in France, Germany, and Britain. Casein was concentrated in German and French hands; they had merged their interests in 1904.

1926 divides the "old" and "new" plastics. The patent for Bakelite ran out that year, and many new plastics were commercially introduced. Cellulose acetate replaced Celluloid, and many familiar plastics, including bead plastics (acrylics, urea formaldehyde, polystyrene) debuted in 1926 or soon thereafter.

Since 1945 plastic production has expanded greatly, and now includes nearly every country in the world. For those who think plastics will die out due to the petroleum shortage, remember that plastics can be made from many organic sources, including wood, milk, soya, lac, and peanuts. Recent research to make plastics from weeds and other cheap celluloid sources has recently sped up.

5.3 <u>COLLECTING PLASTIC BEADS</u> Plastic beads are of interest for two reasons, both connected to their history. In our fast-changing world, objects made 50 years ago take on the glow of an "antique." and some plastic beads are decades older than that. Many early plastic beads were inspired by a new aesthetic, particularly espoused by Coco Chanel. As late as the 1930s, craftsmen in the U.S. were hand carving plastic jewelry, and these are often small works of art.

The other interest comes from their new status in the developing world. Low initial costs, easily taught labor skills, and available technology all help plastic factories in poorer countries to set up. Production in these countries (as remote to many Americans as the Stone

Age) serve local markets and reflect local tastes. We are only at the beginning of what will become a more important chapter in the story of beads.

5.4 <u>CHEMISTRY AND FORMING OF PLASTICS</u> Plastic chemistry is nearly as complex as that of glass. Plastics are organic (carbon-based) compounds which once flowed (were plastic). They are made of polymers or macromolecules, a structure first identified by Hermann Staudinger in 1922. Initial critics of his theory were silenced when he produced polystyrene in 1929 using the principles of his theory. Plastic molecules are large and known as polymers (many parts). When they are arranged in a chain we have a thermoplastic (thermosetting plastic), and when they are linked, forming a lattice, we have a thermoset (thermosetting plastic).

The thermoplastics are more common, and include the cellulosics, acrylics, polyamides, polystyrene, PCV, and the related vinyls. Most are soft, bend rather than break, and when heated melt and harden again into any shape. The thermosetting plastics (Bakelite, urea and melamine formaldehyde, and polyester) break when bent and do not melt easily. Casein is often considered half-way between the two types, as it will flow, but only with great heat and in the presence of water.

The thermosetting plastics are compression molded, pressed from powdered form. Thermoplastics are injected when molten into a mold (injection molded). Both methods were pioneered by J.W. Hyatt for his Celluloid. Though neither worked for his product, they came later to be adapted for the other plastics.

An important plastic beadmaking technique is extrusion, pulling a sheet or tube out continuously in a technique developed for glass in 1844 by Bewely. Only appropriate for the thermoplastics, the sheets can be cut up into beads and the tubes cut apart or blown into molds, as is done with glass beads.

T E S T S: Plastic Molding Processes The compression method (the thermosets) leaves a mold mark, but never any extra material. Injection molding has "flash," extra bits of plastic which seeped between the mold halves. Extruded plastics tend toward tube or sheet shapes; the tubes are often hollow.

* * *

5.5 ADDITIVES Additives are used in plastics for different reasons. Some are stabilizers (anti-oxides, UV absorbers), while others are lubricants. Fillers (carbon, rubber, sawdust, silicates, etc.) are used for reasons not always obvious to the layman, but sometimes as clear as the aluminum sparkles in a table top.

Anti-static agents prevent electrical build-up in production and keep the product from collecting dust on the shelf. I suspect that some plastic "amber" beads were made with a short-lived anti-static agent on purpose to "age" the bead and give it the electric static charge that true amber has.

T E S T S: Plastic Additives Few additives are of much practical interest to the collector, and the tests for some of them are involved. However, wood or rubber fillers often mask the characteristic odor you are trying to detect in the flame test. Some fillers do not burn off; after burning, metal shavings may be spotted. The silica additives (asbestos, talc, mica, diatomaceous earth) leave an incombustible white ash.

* * *

5.6 MAJOR BEAD PLASTICS Here is a short list of plastics used for beads and costume jewelry. Brief descriptions are incorporated with the tests. Review the plastics flame test, section 1.7. Take caution when smelling.

1 Acrylic (Methylmethacrylic) A thermoplastic widely used for beads. It is clear when produced and can be dyed any shade. It is stable, hard, chemically resistant, and transmits up to 93% of the light reaching it. It can be injection or compression molded or extruded. It burns slowly with a blue flame and yellow tip. Molten material bubbles without charring. A fruity smell is released.

2 Bakelite (Phenol formaldehyde) A splotchy amber when produced, it becomes dark when decolorized, perfectly exemplified by a black telephone cover. It hardly burns, though may crack in the flame, and goes out when taken from the flame. It smells of carbolic acid, though additives often smell like burning hair.

3 Casein Usually opaque, the caseins often are crazed or cracked in the U.S. due to the high humidity. It is hard to mold, and therefore usually cut from sheets. It takes a high polish, and slowly absorbs a drop of water. A spot of nitric acid turns bright yellow.

4 Celluloid (cellulose nitrate) Transparent or yellow when formed, it can easily be dyed by driving the pigment in with a roller. Molding is usually limited to flat shapes. It gives off a camphor smell when scratched with a knife, rubbed against the hand, or burned. It burns with a white light and a sharp odor.

5 Cellulose acetate This largely replaced the flammable Celluloid. The two are similar, but in the burning test it burns slowly with a sputtery blue flame, chars and burns at the base. The smell is of strong vinegar.

6 Cellulose acetate butyrate A third cellulosic, it resembles the others, but burns slowly. The smell is rather like rancid butter.

7 Melamine formaldehyde A popular thermoset, it is more scratch-resistant than urea f. and can be made in many pastel shades unlike phenol f. (Bakelite). The flame hardly affects it, and it goes out when withdrawn, cracking only when quite hot. It gives off a fishy smell.

8 Polyesters (Alkydes) Reinforced or unsaturated polyesters are excellent for reproducing fine lines in a die and can be made any color. They show a white mark when scratched with a knife. When burned they give a yellow flame with black soot and a sour cinnamon odor, often masked by fillers.

9 Polyethene This widely used plastic is translucent, can be scratched with a fingernail, and floats in water. It feels and smells waxy, burns with a blue flame with a yellow tip, and gives off a paraffin smell.

10 Polyphenylene oxide Not one of the more common plastics. It is self-extinguishing, and burns with a kerosene smell when translucent, and rubber when opaque.

11 Polyprophylene It floats in water, but cannot be scratched with a fingernail. It burns slower than polyethene, smelling like diesel fumes.

12 Polystyrene An attractive and widely used plastic, it gives a metallic ring when lightly hit or dropped on a hard surface. It melts when burned, giving an orange flame with lots of smoke and some soot. After the flame is blown out, there is a strong acid odor, sometimes masked by rubber in the reinforced variety, which can be detected by noting a white streak when it is bent.

13 Polyvinylchloride (PVC) Difficult to ignite, it burns with a yellow flame, sometines touched with green. Self-extinguishing; odor resembles hydrochloric acid.

14 Urea formaldehyde Similar in looks and properties to the other thermosets. Pastel shaded unlike Bakelite, but never as brightly hued as melamine. A burning gives off a formaldehyde odor, sometimes rather musty.

5.7 A PLASTICS CHRONOLOGY For those with further interest in plastics, this short chronology is appended. It covers the period from the first synthesis of plastic to the eve of World War II.

1833 Braconnot (France) synthesized cellulose nitrate
1835 Polyvinylchloride (PVC) first synthesized
1855 Parkes and Spill began experiments.
1862 Parkes first exhibited xylodine
1865 Parkes credited with first plastic, Parkesine
1868 Spill invented Xylonite
Hyatt brothers invented same material, Celluloid
1869 Hyatt brothers patented Celluloid
Schutzenberger (Germany) produced cellulose nitrate
1870 J.W. Hyatt tried compression molding for Celluloid
1871 Celluloid Corporation established
1872 Bayer (Germany) produced phenol formaldehyde
Hyatt tried injection molding; it was dangerous
1877 Xylonite Company founded in England
1880 Acrylics first synthesized
1885 Spitteler accidentally invented casein plastic
1889 Baekeland, a Belgian, immigrated to the U.S. at 26
1895 Berliner produced lac plastic
1897 Krisch and Spittler perfected casein
1901 W. Smith (U.K.) synthesized polyester, first alkyde
1903 Cellulose acetate patented in U.S.
1904 Germany and France consolidated casein production
1906 Baekeland began experiments
1909 Baekeland patented phenol formaldehyde, later called Bakelite
1910 Bakelite commercially offered.
1912 Polyvinylchloride (PVC) first marketed
1914 U.K. begins casein production, called Erinoid
1918/19 Fritz Pollack invents urea formaldehyde, first aminoplastic
1919 Staudinger published a paper identifying "macromolecules" as the structure of plastic

1919 Bakelite production 10 tons/day in U.S.
1925 Bakelite production 20 tons/day in U.S. (7,000/year)
1926 Division year between "old" and "new" plastics
Cellulose acetate, vinyls, polyethelene marketed
Baekeland's patent ran out
1927 Acrylic marketed
1928 Urea formaldehyde marketed
Celluloid 100 tons/day world-wide
1929 Staudinger synthesized polystyrene
1937 Styrene first marketed
1938 Polyester first produced in U.K.
1939 Melamine formaldehyde marketed
Polyethelene first produced in U.S.

Section Six:

F A I E N C E

6.1 BACKGROUND Faience was the first synthetic material and the first glazed ware. From about 3200 BC it was an important bead material for thousands of years, coming to be replaced by glass on a major scale about 500 BC. Today it is only made in Qom, Iran, and Qorna, Egypt, and by a few modern craftspeople.

Despite its long use, faience is a material we do not know well, as we do not encounter it in our daily lives. This is not only true for the layman, but the experts often do not know what to make of faience either. Indeed, we might say we have a "faience problem" as faience and many other materials are confused with each other, and we lack systematic terms for it.

The solution is to stop thinking of faience as a material with an unvarying formula. We must recognize a "faience family" in much the same way we acknowledge different types of glass or plastic.

6.2 DESCRIPTION We can best understand faience by seeing how it is made. A crushed silicate is mixed with a bit of clay and water, formed into a bead shape, and heated. A straw in the center burns off leaving a perforation, and the particles fuse only where they touch (sintering). Then an alkali and coloring matter (usually copper for the favored blue) are added to the surface and the bead is heated again. This time the alkali and silica at the surface fuse to form a glaze, a thin coat of glass. The core, however, is not affected, and it remains granular and only physically bound together.

Faience can also be made in a single step in which all the ingredients are mixed together and molded into a bead. This is dried in the sun for a few days and the alkali and colorizer migrate to the surface (wicking out). When the bead is subsequently heated only once, the glaze forms. This is called "self-glazing."

The dichotomy of the glaze and core results in faience being usually found in a corroded state. The differences in coefficients of expansion between the two parts cause the glaze to fall off. Thus, most faience recovered from old sites no longer has any glaze.

6.3 THE FAIENCE FAMILY One of the problems with the identification of faience in the past has been that it had been thought that only quartz went into the making of faience. Steatite faience from ancient India was recognized in the 1930s, but only recently has it come to be recognized that this material has been more widely used. The faience made in Qorna, Egypt, today is of this type.

Feldspar, chalcedony, flint, and opal are also alternate faience materials, each producing slightly different types. Work is in progress which may clear up some mysteries about faience. In the meantime, we can conclude that faience was a more widely variable material in the past than had been previously thought.

A last word: paste is not an appropriate term to substitute for faience, though it has often been used in this way. Correctly, paste can only refer to wet, plastic material or the fine lead glass used for the manufacture of rhinestones.

T E S T S: Faience Faience has a glaze, though often missing, and underneath a granular core. Held up to the light the core of quartz faience is translucent where thin. Hardness varies, but is usually about 5. Even with the glaze missing, the core reveals something about the nature of the faience. Self-glazing faience has light coloring all through the core. Faience with a white core most likely had a blue glaze, while a brown core indicates an original green glaze.

Quartz faience is hard and durable, while steatite faience weathers badly, and is often fragile and even powdery. There is a glassy faience (sometimes called vitreous paste) which looks rather like glass, but has a pitted surface and minute granules, unlike glass. It is always opaque.

* * *

SUGGESTED READING

(Condensed Bibliography)

General:

Beck, H.C. (1928) Classification and Nomenclature of Beads and Pendants (reprint, 1981) Liberty Cap, York, PA.

Brady, G. (1963) Materials Handbook, Mc Graw- Hill, New York (9th ed.)

Forbes, R.J. (1957, etc.) Studies in Ancient Technology E.J. Brill, Leiden, Netherlands (10 Volumes).

Francis, P. (1979) A Short Dictionary of Bead Terms and Types, Lapis Route, Lake Placid, N.Y.

Lucas, A. (1962) Ancient Egyptian Materials and Industries, Edward Arnold, London (4th ed.)

Quiggen, A.H. (1949) A Survey of Primitive Money, Methuen, London.

Rosenfeld, A. (1965) The Inorganic Raw Materials of Antiquity, Weidenfeld & Nicolson, London.

Glass:

Brill, R. (1963) "Ancient Glass," Scientific American 209: 5.

Francis, P. (1979) The Story of Venetian Beads/(1979) The Czech Bead Story/ (1979) Third World Beadmakers/ (1982) The Glass Beads of India, Lapis Route, Lake Placid, N.Y.

Kidd, K. (1979) Glass Bead-Making from the Middle Ages to the Early 19th Century, Parks, Canada, Hull, Quebec.

Knapp, O. (1965) Devitrification of Silicate Glass Akademiai Kaido, Budapest.

Lamb, A. (1976) "Krobo Powder-Glass Beads," African Arts IX: 2. (African dry-molded beads)

Ross, L. (1974) "Hudson's Bay Company Glass Trade Beads: Manufacturing Types Imported to Fort Vancouver," Bead Journal 1: 2.

Turner, W.E.S. (1954/56) "Studies of Ancient Glass and Glass-Making Processes," J. Society of Glass Technology XXXVII - XL (six parts).

Stones: Rocks and Minerals

Aitchinson, L. (1960) A History of Metals, Macdonald & Evans, London (2 Volumes).

Bauer, M. (1904) Precious Stones (reprint, 1968, in 2 volumes) Dover, New York.

Cox, W.E. (1944) The Book of Pottery and Porcelain, Crown, New York (2 volumes).

Francis, P. (1982) Indian Agate Beads, Lapis Route, Lake Placid, N.Y.

Frondel, C. (1962) The System of Mineralogy (of J.D. Dana) Vol. III: The Silicas, John Wiley, New York.

Gill, J.C. (1978) Gill's Index to Journals, Articles, and Books Relating to Gems and Jewelry, Gemological Institute of America, Santa Monica, CA.

Sinkankas, J. (1966) Mineralogy, Van Nostand Reinhold, New York.

Organic Materials:

Allen, J. (1975/76) "Amber and its Substitutes," Bead Journal 2:3 - 3:1 (3 parts).

Jackson, J.W. (1917) Shells as Evidence of the Migration of Early Cultures, Longmans Green, London & New York.

Jernigan, E.W. (1978) Jewelry of the Prehistoric Southwest, School of American Research, Santa Fe, N.M.

Muller, H. (1980) Jet Jewellry and Ornaments, Shire Publications, Aylesbury, U.K.

Oakley, K. (1965) "Folklore of Fossils," Antiquity 39 (2 parts).

Slotkin, J.S. & K. Schmitt (1949) "Studies of Wampum," American Anthropologist 51: 2.

Watt, G. (1889) A Dictionary of Economic Products of India (Vol. I "Beads") Government Printing, Calcutta.

Plastic:

Dickinson, T. (1948) A Plastics Dictionary Pitman & Sons, London.

Gupta, R.K. (undt.) Handbook of Small Scale Plastic Industries, Small Business Publications, Delhi.

Yarsley, V.E. & E.G. Couzens (1956) Plastics in the Service of Man, Penguin, Harmondsworth, U.K.

Faience: (see also Lucas)

Stone, J.F.S. & L.C. Thomas (1956) "The Use and Distribution of Faience in the Ancient East and Prehistoric Europe," Proc. Prehistoric Society XXII.

I N D E X

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