Tamarind Technical Papers

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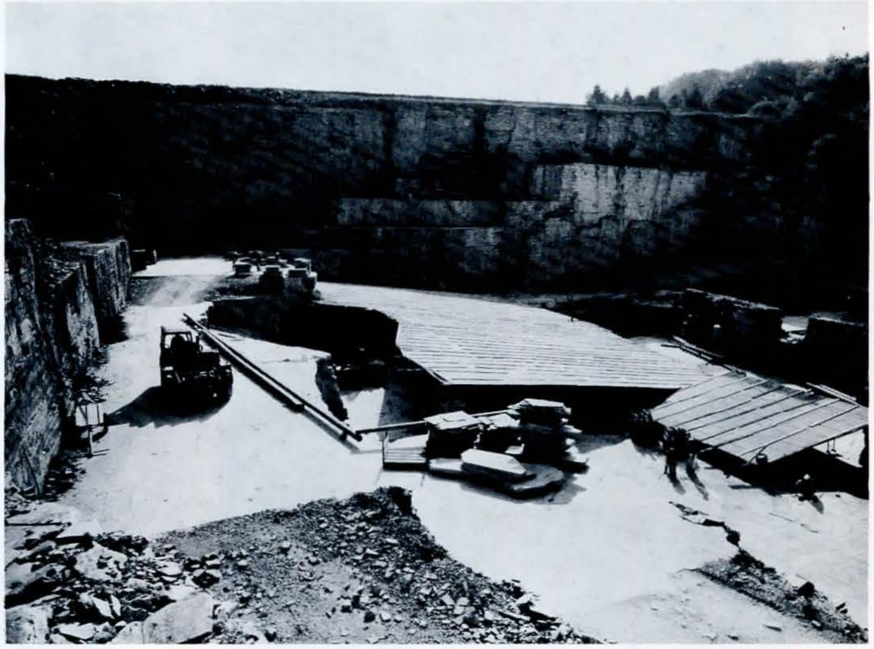
Number 4 / July 1975

With the abandonment of stone for commercial printing, many of the flawless, gray lithograph stones that had been quarried in the nineteenth century were broken up and used for landfill. Such stones as survived are now costly and hard to find. While it may not be true, as Senefelder wrote in 1818, that "no scarcity is to be feared for centuries," it is encouraging to know that the quarries still produce fine stones —although at an increasing price.



A general view of the main quarry, **Oberer Maxberg**, at Solenhofer Aktein-Verein, where the finest gray lithograph stones continue to be quarried.

THE SOLNHOFEN QUARRIES
by Vernon A. Clark

Contrary to many false reports, the quarries of Solenhofer Aktein-Verein, near the village of Solnhofen in southern Germany, continue to produce fine stones for lithography. True, the production of lithograph stones is no longer the primary business of the quarries, as most of the stone from Solnhofen is now used for floor tiles, wall tiles, and stair treads. Even so, lithograph stones are quarried day in and day out, carefully inspected for suitability, and shipped all over the world.

Solenhofer Aktein-Verein, the largest and most important quarry in the area, is now the only one still interested in producing stones for lithography. Alphons L. Zehntner, who had in 1929 been appointed general manager of this old and famous quarry, was the last owner of the Senefelder Company, the primary source of lithographic materials in the United States until that time. In 1954 he sold his interests to a supplier in the commercial lithographic field. Today, the quarrying of stones is conducted under the direct supervision of Dr. Theo Kress, Director of Aktein-Verein, and his assistant, Herr Glöckel. It is evident in every aspect of the quarry's operation that they, the quarrymen, and stoneworkers take great pride in the stones they produce.

Quarrying is not an easy task, and much physical effort is required to extract the stones from the earth. Explosives cannot be used, as they would cause the stone to shatter. Instead, craftsmen laboriously use sledges and wedges to loosen each piece of stone from the bench in which they are working. Normally two of these Craftsmen—and they are craftsmen with a capital "C"—work together, driving their wedges into the layer of rock, and ultimately using an even larger sledge to break that particular piece loose from the shelf. Between the layers of limestone is a softer material called mudstone. As mudstone has no commercial value it must be hauled away and disposed of.

The slab of limestone that has been dislodged is turned upside down and inspected for obvious faults. It is then broken into pieces of a size that can be handled by a lift truck. While the breaking of the stone sounds like a simple operation, it is most interesting to watch. The craftsmen break the stone precisely where they intend it to break. No sculptor has a more thorough knowledge nor a better feel for the stone than do these

Right: Stoneworkers on the upper levels of the main quarry. **Oberer Maxberg.**

On the facing page:

1. Workmen begin to grind a lithograph stone on a special machine with diamond tools.
2. Specialist stoneworkers finish the edges ot two stones.
3. Herr Glöckel (right) and a specialist examine a very large yellow stone, about 42 x 56 inches.
4. The two stones in the foreground have been cemented but not yet cut and finished.
5. Lithograph stones in rows, ready to be packed and shipped.
6. Dr. Kress (left) and Herr Glöckel stand beside the special machine used to grind lithograph stones.

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Editor: Clinton Adams

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Unsigned notes and articles are written by the Editor.

men. They chalk out lines, then use a chisel and hammer to ding the stone along these lines. At the end, one more swing of the sledge and the stone is in pieces, ready to be handled by the fork lift.

Exciting fossils are sometimes found in this limestone—laid down in the Jurassic era, between 135 and 180 million years ago. Although fossils in stone may be the bane of lithographers, it should also be remembered that the Solnhofen quarries have been the source of some of the world's most important fossil discoveries. When fossils are found, they are handled with great care, finding their destination in museums throughout the world.

"The stone that has been used exclusively hitherto in Munich for printing is a stratified limestone, found in the territory from Dietfurt to Pappenheim, and along the Danube down to Kellheim; hence the name Kellheimer plates, presumably because in past times the stone was quarried there first, or else found in the best quality. Now the Kellheimer quarry is exhausted, and the trade in the stones has transferred itself to Solnhofen, a village in the judicial district of Mannheim, three hours distant from Neuberg-on-the-Danube. All the inhabitants of Solnhofen are quarrymen, and the entire surrounding country seems to have a surplus of the stone, so that even with the greatest demand no scarcity is to be feared for centuries." ALOYS SENEFELDER

After being cut, the stone is taken from the quarry and begins its trip through the stoneworks. It receives a second inspection, at which point stones which are obviously unsuitable for lithography are set aside for commercial uses. Stones which have a potential as


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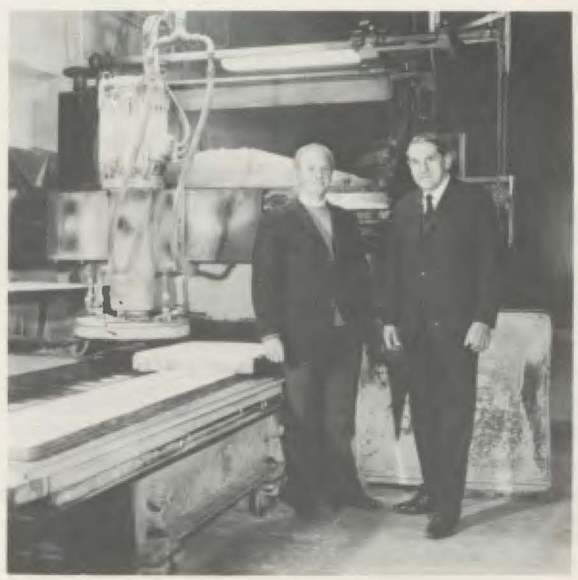
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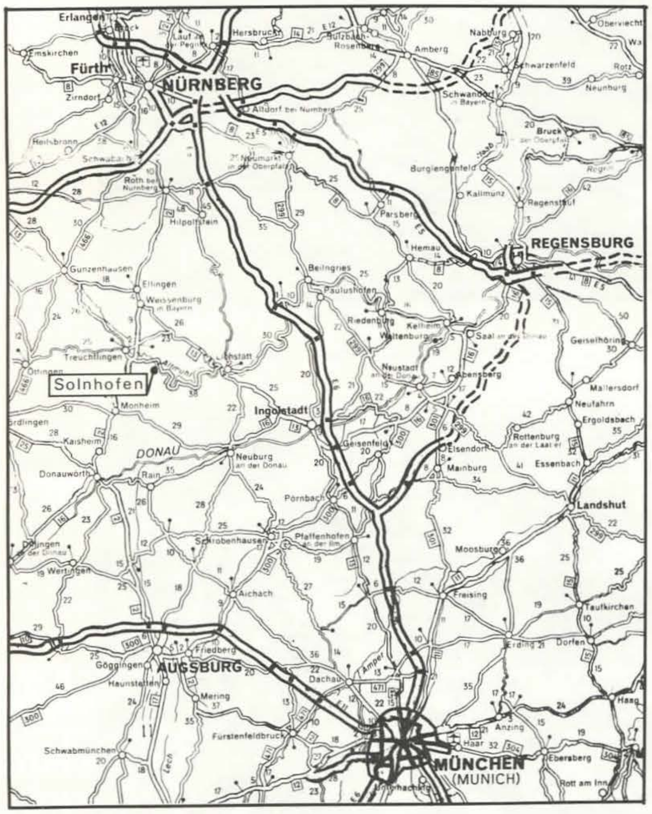

The village of Solnhofen is too small to appear on most maps of southern Germany. About halfway between Nürnberg and Munich, it is near the Altmühl River.

lithograph stones are taken to a building where, through the use of a fantastic machine with diamond grinding wheels, they are ground and again inspected, this time by Herr Glöckel, an expert judge of fine stones. He and a workman go over each stone, inch by inch. If they like what they see, the stone is given a number. During the process of inspection the stone is first dusted and examined while dry, then sponged with water and examined wet. A week or so later Dr. Kress repeats this routine for a second time. He and Herr Glöckel seldom disagree. If necessary, however, it is possible to finish a stone and print from it at Aktein-Verein, this as final proof of its quality.

In the United States we ask for stones of varying thickness, usually in excess of three inches. Such thicknesses can often be achieved only by cementing together two thinner sheets of stone. The cementing is done before final trimming and finishing of the stones by the expert stoneworkers (see illustration 4, where two such cemented stones rest on the sled in the foreground).

All stones are finished by hand by skilled stoneworkers. The edges are meticulously finished first with cutting chisels, then with a second tool that produces the roughened pock marks familiar to lithographers. When finished, the stones are slightly larger in the middle than at top or bottom. Stones with edges worked in this way are better protected against possible damage while resting on their edges (as in illustration 5). Very few workmen are available who have the requisite skill to finish these stones, and not many stones a day can be finished by a workman. The tree trunks upon which they work (seen in illustration 2) provide a resilience which assists in avoiding breakage.

After a final polishing with the grinding machine, the good side of each stone is rubber stamped, "Made in Germany." Each stone is precisely flat, its surfaces parallel. It leaves the quarry only after repeated inspections. Only when it is in every way satisfactory to Dr. Kress and Herr Glöckel may it be carefully packed, together with other stones, in wooden crates interleafed with excelsior. In these crates the stones are sent off on their long journeys to the United States, India or Australia.

AKTEIN-VEREIN has other things to offer as well. A small but fine museum is operated as a part of the physical plant at the quarry. The first room and part of the second room at the museum (which has a small admission charge) are devoted to lithography. On display are Senefelder's original, portable lithograph press and a copy of his second press. There are other presses too, and the walls are lined with fine lithographs, both old and modern. The balance of the museum's second room is devoted to use of the stone as floor tiles, and includes an ancient pool built by the Romans about 200 A.D. and reassembled at Aktein-Verein in the past two years.

The museum's third gallery is devoted to fossils of all sizes and shapes, each more beautiful than the one before. Also shown are stone curiosities: limestone crystals of different shapes; stone plates covered with dendrites; naturally colored pieces of stone, ranging from gray to reddish-brown and violet; sections of layers as found in the quarries, revealing the varying thicknesses of stone; and, last but not least, two maps that show the extent and area of the Solnhofen stone deposits.

Located about halfway between Nürnberg and Munich, the museum is readily accessible by car and of certain interest to every lithographer. Although visitors are welcomed at the museum, Aktein-Verein is a working quarry, with the result that there is no provision for tours, and visitors are not taken through the working areas.

Vernon A. Clark is President of Graphic Chemical and Ink Company, Villa Park, Illinois.

Photographs by **Solenhofer Aktein-Verein**, Solnhofen, West Germany.

THE USE OF SLATE IN BACKING LITHOGRAPH STONES

by John Sommers

As all lithographers know, the cost of lithograph stones has increased rapidly during the past few years. Used lithograph stones are now seldom available, and the day of the sudden discovery–a cache of unused stones in a basement in Cincinnati, St. Louis or San Francisco–has all but come to an end. The combination of rising labor and shipping costs, coupled with the devaluation of the dollar and the revaluation of the German mark, has caused the price of newly quarried stones to rise to ever higher levels.

Fine stones are thus a resource of great value–one which should be protected and conserved with all possible care. Lithographers should as a matter of standard practice regularly take inventory of their stones. All things being equal, the thinner the stone and the larger its size, the greater the danger of its loss through breakage. To make use of stones less than three inches in thickness is to assume unnecessary risk.

At the quarries thin sheets of limestone are routinely cemented together (see the article above). In the workshop, however, suitable backing stones are seldom available, and it has thus been historic practice to use sheets of slate for this purpose. Because of its high strength and durability, as well as its surprisingly low cost, slate is ideally suited to such use.

Ribbon slate may be obtained on order from The Structural Slate Company, Pen Argyl, Pennsylvania 18072 (Mr. John H. Lee is General Manager). It is available in thicknesses of one inch, one-and-a-half inches, and two inches, and in all sizes. It is flawless and can be ground to fine tolerance at the quarries for a small additional charge.

The backing of a stone should proceed as follows:

1. A piece of slate should be ordered in a size identical to the stone and of such thickness that the stone and slate together will measure between 3½ to 4½ inches.

2. The stone should be freshly grained and carefully checked for flatness, following the procedures described in TBL, Seciton 1.4 (see also illustration j, page 25).

3. The slate itself is then grained and checked for flatness in the same manner.

4. The stone is placed, back-side up, on a firm level surface. If there are large pits or chips in the back of the stone they should be filled with automobile body putty and trimmed flat and smooth. This putty is an epoxy compound and should be mixed and used in accordance with the instructions that accompany it.

5. The bonding material to be used in joining the stone and slate is clear epoxy cement. Such cement is sold in quart or gallon cans together with separate bottles of hardener. One quart of epoxy usually requires four ounces of hardener. The manufacturer's instructions should be followed carefully, as use of either too little or too much hardener can result in problems.

6. The epoxy is mixed on the back of the stone and is spread evenly in all directions using a serrated, plastic linoleum spatula. A 24 x 32 inch stone will require from four to six ounces of cement.

7. When the stone is coated with an even layer of cement the dry sheet of slate is placed on top of it and slowly jiggled into position. The jiggling of the slate helps to eliminate air bubbles, while smoothing the epoxy between the layers of stone. Some cement may be expected to run down the sides of the stone; such excess cement assures a good bond between the two surfaces. It is easily wiped off with a rag.

8. Small stones are then piled on top of the slate, their weight evenly distributed, and are left in place for twelve to twenty-four hours.

9. The seam between the stone and its slate backing should be filled with automobile body putty. After sanding, the edge should then be painted. Thus joined to the slate, the stone may be used with far greater safety than before.

Slate may also be used as a backing for heavy gauge metal plates, either zinc or aluminum. When bonded to slate such plates may be hand grained with the levigator and used as printing elements. Alternatively, two-inch thicknesses of slate, carefully grained to be flat and true, may be used on the pressbed as backing for standard gauge metal plates.

PEDRARA ONYX: ITS USE IN LITHOGRAPHY

by Clinton Adams

Senefelder was the first to realize that the new process he had invented did not depend primarily upon the special qualities of the Solnhofen limestone. In his book he commented explicitly on "chemical printing" from metal plates (iron and zinc were mentioned; aluminum was not then available) or "stone-paper." He was also aware that marble might be used instead of limestone.

> "I have found many evenly colored greenish, gray, bluish and brownish Bavarian and Tyrolean marbles very useful for some methods, especially because of their superior hardness. . . . The white Parian or Carrara marble is still lighter in color to be sure, and really is rather useful for pen and crayon work."[1]

Senefelder nonetheless had reservations about these alternative stones, noting that "the Solnhofen stone will retain its advantage because of its light color and its greater cheapness."

As the advantage of cheapness is no longer there, the time has certainly come once again to explore the possibilities that marble and marble onyx may present for lithography.[2] A most promising source of such stone is found in the immense marble onyx quarries of Baja California. Here, in this desert peninsula, lie what may well be the world's largest deposits of fine marble onyx.[3] Long quarried for architectural and ornamental purposes, this stone is available in slabs of a size suitable to lithography, and is imported into the United States by the Southwest Onyx & Marble Company of San Diego, California.[4]

Although of different geologic origin, the Solnhofen limestone and the Pedrara onyx are similar in chemical composition.[5] The greater hardness of the onyx (hardness 3.5) and the crystalline structure of the calcium carbonate (calcite) cause it to have an appearance quite different from the limestone. The piece of onyx used for the tests described below was one inch in thickness, translucent, and white in color, with faint streaks of ochre and brown.

	Solnhofen Limestone	Pedrara Onyx
Calcium carbonate, lime, and carbon dioxide	96.49%	90.16%
Silica	1.15	--
Metallic salts (iron, manganese, magnesium, etc.)	1.27	9.39
Water	.92	.38
Other	.17	.07
	100.00%	100.00%

Printing from onyx

Stephen Britko began a series of experiments in printing from onyx in February of 1975.[6] Aware of earlier problems (see note 2), Britko first backed the onyx with a one-inch sheet of slate (see article above) and grained it in the normal manner.

He then made test drawings using crayons of grades one through five and processed the onyx for printing. His initial etch ranged from two drops (in the areas drawn with crayons 4 and 5) to eight drops (in the areas drawn with crayons 1 and 2). The image came up quickly and a good bit darker than drawn.

Britko concludes that the appearance of the stone led him to underetch it. Because of its hardness, onyx is quite capable of withstanding a stronger etch than can be used on all but the finest blue-gray stones.

He gave the crayon drawing a heavier second etch, this time ranging from 5 to 12 drops (all references to etch strengths are expressed in drops of nitric acid per ounce of gum arabic; gum arabic of pH 5.0 was used in all of Britko's tests).

With some concern as to the pressure that onyx could accommodate, the first impressions were pulled with light pressure on damp paper. They were excellent. Five impressions were then pulled on dry paper, this time with medium pressure; again they were excellent.

Following this proofing session, the onyx was counteretched and additions were made with crayon, rubbing crayon, zincographic ink, and several kinds of tusche. Britko makes the following observations:

"The counteretching and etching had its effect upon already established areas. They were now lighter and more grainy; the light tones had dropped out, and the washes etched with a 15 drop etch had been burned.

"Some areas had been counteretched with acetic acid, others with citric acid; in all cases the grain of the stone was affected by the counteretch."

Britko's conclusions, as a result of these experiments, are that

(1) washes on onyx will work best if the grease content is relatively low;

(2) *La Favorite* tusche is superior to Charbonnel; both are superior to Korn's, which tended to fill in;

(3) the onyx should be strongly etched;

(4) if, despite the first etch, washes roll up heavily, a strong second etch is indicated; and

(5) firm pressure is needed for a good impression and, backed with slate, the onyx can withstand it.

As a final test of the onyx, Britko reversed the image using Liquitex (see TTP 2, pp. 13-20) with complete success.

All of Britko's tests served strongly to confirm the excellent qualities of Pedrara Onyx as a printing element for lithography.

1. Senefelder, Aloys. *The Invention of Lithography.* Müller translation, 1911, page 102.

2. Tamarind's first experiments with Pedrara onyx were conducted in Los Angeles by Robert Evermon and are briefly reported in TBL, section 9.6, page 267. Evermon's experiments demonstrated the excellence of this marble onyx as a printing element, although he encountered problems caused by breakage of the brittle stone under pressure. At that time the difference in cost between Solnhofen limestone and Pedrara onyx was not so great as now.

3. The nature and properties of marble onyx are not widely known. We are indebted to John Y. Mills, President of the Southwest Onyx & Marble Company who has sent us a pamphlet (c. 1910?) by his predecessor, F. J. Lea, and an article by J. W. Fisher, "The Pedrara Onyx Quarry at El Marmol, Lower California" (in *Mineral Notes and News*, June, 1947), which are the sources of the following quotations:

"Much confusion exists in the use of the word 'onyx.' True onyx is a black and white banded chalcedony; and sard-onyx is a red and white variety. Calcium carbonate is commonly deposited from solution in successive layers of varying tones or colors resembling onyx, hence such calcareous rock is also called onyx. To distinguish the calcareous (Calcite and Aragonite) from the siliceous ones (chalcedony or crypto-crystalline Quartz) the former is called 'onyx marble.' It is sometimes designated 'Mexican onyx' because famous deposits are situated in Mexico.

"Onyx marble and travertine are of similar origin. Calcium carbonate is practically insoluble in pure water but is somewhat so in water charged with carbon dioxide. Thus, carbonated springs may carry calcareous solutions, but upon reaching the surface the carbon dioxide is dissipated in the atmosphere, and, the solvent being lost,

Please turn to page 48.

ZINC ETCHING PLATES AS PRINTING ELEMENTS FOR LITHOGRAPHY

by Clinton Adams and John Sommers

When Tamarind opened its Los Angeles workshop in the summer of 1960, regrainable zinc plates for lithography were still readily available. As the use of disposable aluminum plates became widespread in the offset printing industry, there was a parallel decline in the use of zinc plates, and the companies that had been supplying zinc gradually stopped doing so. Lithography workshops that wished to continue to use zinc plates already on hand were forced to acquire ball-graining equipment (see TTP 3, pages 32-33). The commercial graining companies soon went out of business.

Despite these problems, zinc continues to have many attractions for artists. For most types of wash drawing, zinc is superior to aluminum; for some, it is superior even to stone. *Peau de crapaud* is a visual quality attainable only on zinc (see TBL, illustrations 6.6-6.8 and section 6.11).

Although zinc lithography plates in the .010″ caliper thickness can now seldom be found, zinc plates for use in intaglio printmaking are readily available.[1] In the spring of 1975 such a plate was used experimentally at Tamarind in the following manner:

1. The surface of the plate was first thoroughly cleaned with lacquer thinner. It was then placed in the ball-graining machine for two one-hour cycles, using four ounces of #320 aluminum oxide grit and four ounces of trisodium phosphate. At the end of the first cycle the slurry was dumped and new graining materials were added for the second cycle. Because of the thickness of the plate, it was necessary to use a larger than normal number of steel graining balls (of ⅜ and ½ inch diameters) so as to crowd the balls over the high edge of the plate and into the center area. Without such an excess of graining balls, the center of the plate would not have been adequately grained.[2]

3. A drawing was made on the freshly grained plate using *La Favorite* paste tusche. Four diluted washes were prepared using 15, 20, 30 and 40 drops of concentrated tusche solution in one-quarter ounce of distilled water. *Peau de crapaud* textures formed on the plate within a few minutes after application of the washes. The boldest *peau de crapaud* patterns were formed by the richest washes. *Peau de crapaud* formation was also affected by the amount of liquid used and the method of application. A sweeping and fluid application of the 40-drop wash produced curved and elongated *peau de crapaud* following the brush stroke. A pool of 20-drop wash (not brushed) formed a fine pattern of tiny dots. A 30-drop wash, to which a small amount of Chinese white watercolor had been added, produced a large, bleeding *peau de crapaud.*

4. The drawing was dusted with talc. An etch composed of equal parts cellulose gum (Hanco MS 448) and tannic acid plate etch (Hanco MS 214), five ounces in all, was then applied with a brush for a period of three minutes.

5. After thirty minutes the plate was washed out with lithotine followed by lacquer thinner through a hydrogum film. Asphaltum was applied and washed off (using distilled water), and the plate was then rolled up with a medium, stiff black ink. It rolled up very slowly. The initial etch had apparently been too strong, as the 15-drop washes had disappeared, and the 20-drop washes came up very slowly; their interior grays were gone. After a second etch, proofs were pulled to ascertain the plate's stability.

6. The plate was counteretched with Richgraphic counteretch 0108. Additional washes were added, this time using Charbonnel paste tusche (the dilutions in strength were the same as those used for the initial drawing). The strength of the etch was reduced to one part cellulose gum and two parts tannic acid plate etch.

7. When rolled up for the second time, the image was rich and full (perhaps too rich in the areas drawn with the 40-drop wash). It was completely stable.

ZINC ETCHING PLATES were thus demonstrated to be fully suitable for use in lithography. The artist may employ any drawing technique which does not result in a grease content exceeding etch possibilities. Drawings with crayon will process well.

It is not recommended that the plate be put in lacquer base or that it be stored for long periods before printing. It is characteristic of zinc that stored images lose stability, and this plate proved to be no exception to that rule. When stored for two months, the washes had grown and filled. Although a wet wash and re-etch returned the plate to its former openness, its earlier stability was not regained.

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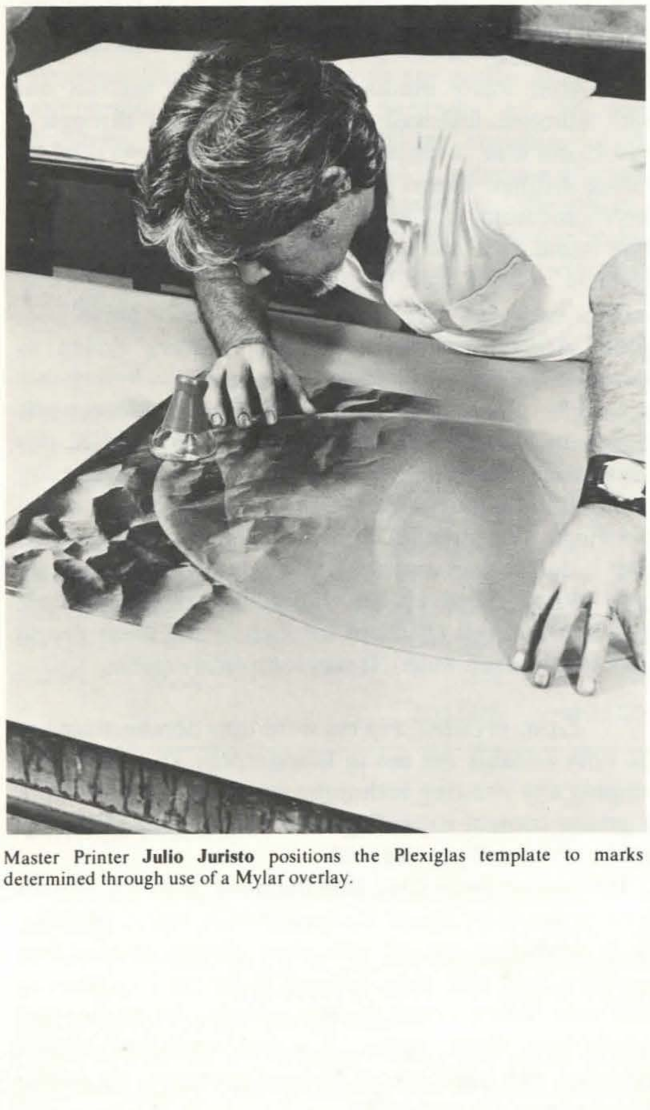
1. The plate used at Tamarind was a Revere Triple Metal Zinc Etching plate, 24 x 36 inches (16 gauge) and was purchased from the National Steel and Copper Company, 700 South Clinton Street, Chicago, Illinois 60607.

2. Lithographers who do not have access to a graining machine, but who are interested in work with *peau de crapaud* textures, might consider bonding a zinc etching plate to a one-inch slate backing stone as described in the article above. The plate could then be grained by hand using a levigator.

PRECISION DELETIONS ON LITHOGRAPHY PLATES

by Julio Juristo



Master Printer **Julio Juristo** positions the Plexiglas template to marks determined through use of a Mylar overlay.

A new and superior method for making deletions on aluminum plates was brought to our attention at GRAPHICSTUDIO by artist James Rosenquist in the summer of 1974. He had been using a Paasche air eraser, type LA-3, to delete portions of images on aluminum plates in his work in New York, and when he came to Tampa for a proofing session he included such an eraser in the gear he brought along.

I quickly saw the ease and control that this method affords the printer and bought a similar version (model AEC-3 air eraser with carboloy tip) for my own use. Each of these models comes with tips of various sizes, and a check of the Paasche catalog should be made to determine individual needs.

If the planned deletion is to be a simple one, masking tape and cover stock may by used to cover and protect the portions of the image that are to be retained. The plate should be rolled up fully, dusted with talc, gummed tight, and dusted with talc again prior to masking. Since No. 220 carborundum grit is to be used for the erasure, the work should be set up in an area which will not lead to contamination of other materials, preferably outdoors. It is an extremely messy operation.

In the case of Rosenquist's work, we were working with 38 x 86 inch plates. We taped one plate to the outside of the GRAPHICSTUDIO building; the other was placed flat on a masonite sheet on our loading dock. The latter method proved to work out best, as there was less wind interference and it was easier to reposition the air eraser as work progressed.

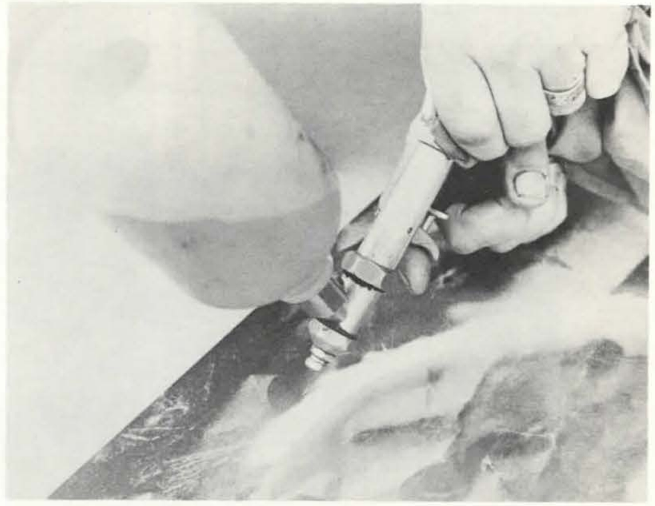
Shown in the accompanying illustrations is one of the four plates which together formed a single, multicolor, sunglass lens-shape. Because of the precise registration that would be required, a Plexiglas template was cut and registered to each plate through use of impressions pulled on Mylar. Double-faced contact paper was placed on the inside Plexiglas surface and pressed against the plate. Then, while an assistant wearing rubber gloves pressed down on the edge of the Plexiglas, the deletion was made, using the air eraser.

In making such deletions, care should be exercised not to remain too long in one area, as prolonged stationary use of the air eraser results in an excessive removal of metal. A sweeping action is best, with repeated pauses in which to reposition the eraser in relation both to the work and to air currents.

Julio Juristo, Tamarind Master Printer, is a member of the staff at Graphicstudio, Tampa, Florida.

Photographs by **Patrik Linhardt.**

Right: Close-up view of the Paasche LA-3 air eraser.

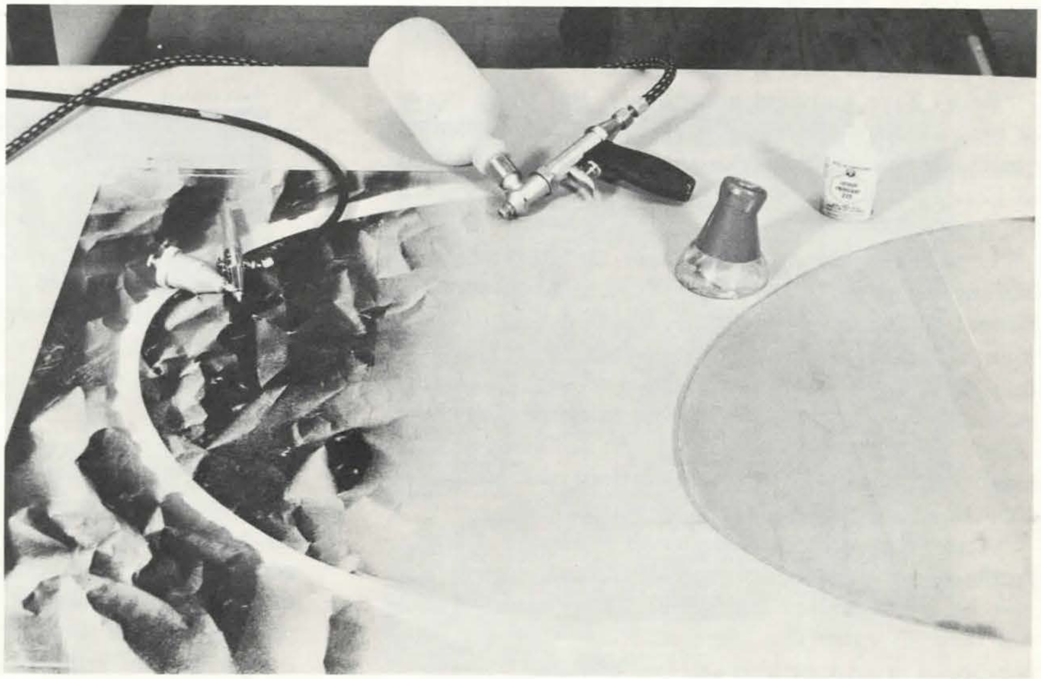


Use of the air eraser on the Rosenquist plate resulted in a clean area, about one-half to one inch wide, around the image that was to be retained. The remainder of the unwanted image was later removed with Polychrome image remover No. 229. The residue of the image remover was cleaned off with damp wipes, without disturbing the oval image. A small sponge and acidified cellulose gum were then wiped over the area of the deletion, to the edge of the oval shape. When the plate was dry, it was washed out normally, asphaltum was applied, and it was ready for roll up. After a mild cleaning of the negative areas with a 5:1 solution of water and plate cleaner, the entire plate was given a Pro-Sol treatment.

There are times when the shapes to be deleted and the shapes to be retained are such that they cannot be treated separately as described above. In such cases, the entire plate should be flushed with the water hose, regummed, and buffed tightly but very gently. I stress the word gently, because there is always the possibility that a small amount of grit may seep under the masking and cling to the ink, no matter how well the masking is done. Vigorous gumming and wash out would inevitably lead to scratches. With very gentle treatment, however, the gumming and wash out can be accomplished successfully.

Above: Close-up view of the Paasche AEC-3 air eraser poised above the plate and Plexiglas template.

Below: The air eraser has been used to complete the deletion around the oval area masked by the template (now seen at far right). The remaining area to be deleted will be removed with Polychrome 229. At left is the Paasche air eraser AEC-3. In the center is the larger model LA-3.



GUM ARABIC: IS THERE AN ALTERNATIVE?

by Clinton Adams and John Sommers

Gum arabic, the viscous, water-dispersible gum secreted by the acacia trees of the desert regions of the Sudan and Senegal, has been known and used since antiquity. Long before the invention of lithography, it served a diversity of purposes–in the making of candies and medicines, as an adhesive, and in watercolor paints.

The acacia trees that produce the gum do so in ways that are not completely understood. The gum forms beneath the bark of the trees during the long dry seasons from November to June. When the bark is cut or bruised, the gum exudes and forms as "tears" on the tree, in which form it is collected and taken to Khartoum, the center of the gum trade, where it is sorted and packed.[1]

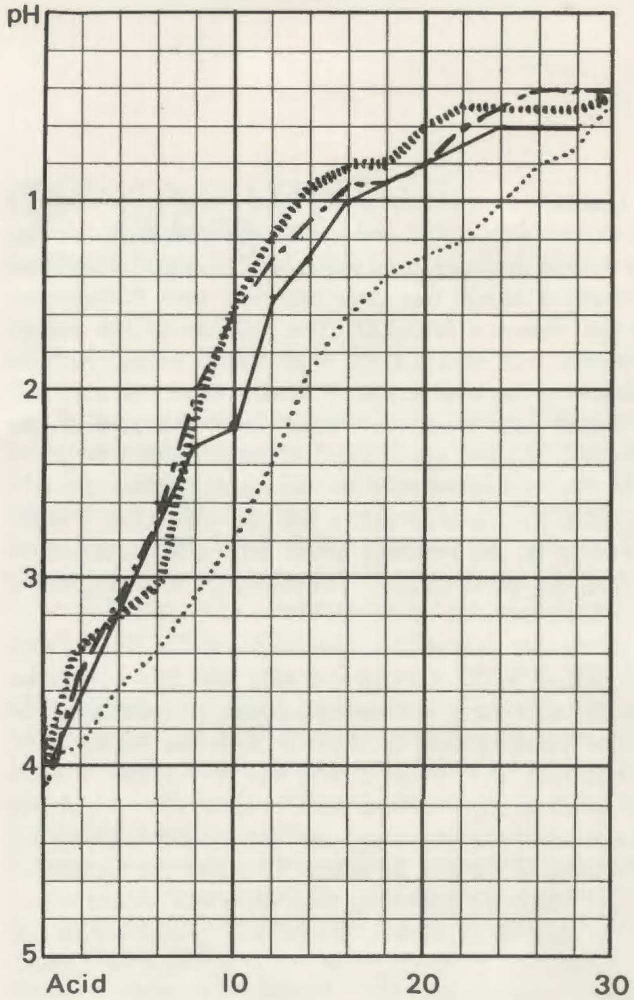
In the early 1970s a major crisis arose in the markets for gum. "The problem," as reported by *The Wall Street Journal,* "is that Africa's lengthy drought has led to a sharp drop in gum collection by the nomadic tribesmen who roam so called 'gum gardens' and collect the stuff in the Sudan and parts of West Africa.

"Prices have mounted accordingly. But while prices of better-known commodities have doubled, tripled or quadrupled in the past year, the gum arabic quotation in London has multiplied nearly ninefold to $3,172 a ton from $364 a ton."

"London trade sources estimate the current year's Sudanese crop won't exceed 25,000 tons, about half the normal yield. . . . The Gum Arabic Co. [a monopoly founded by the Sudanese government in 1969] attributes its problems to 'an unprecedented heavy demand' as a result of 'virtual crop failure in other sources of supply,' such as Mauretania, Senegal and Nigeria. Dry conditions in the Sudan also hamper the ability of collectors there to roam watering places.

"Actually, the acacia trees don't mind the drought. Authorities differ on exactly what makes an acacia tree give off its highly soluble, tasteless gum when tapped, but they do agree that the tree gives off more under conditions of extreme heat and lack of water."[2]

GRAPH 1



Gum arabic solution prepared from crystals, 14° Baume.

Hanco preserved gum arabic, MS 587 (F18342), 14° Baume.

Hanco preserved gum arabic, MS 587 (F19127), 14° Baume.

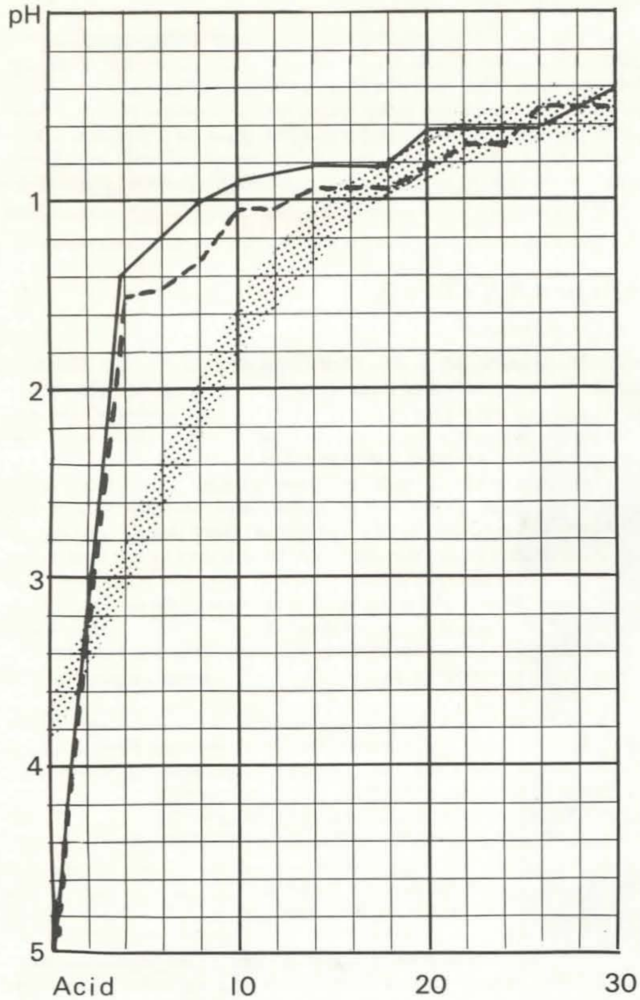
Note: The two Hanco gums (F18392 and F19127) are the same product but approximately one year apart in production.

Hanco cellulose gum, MS 448 (F18147)

Whether the trees mind the drought or not, it has been an unquestioned disaster for lithography workshops. The retail price of gum has skyrocketed, reflecting the shortfall in its production, and the substitutes that have been marketed have been fraught with problems.

In HAND LITHOGRAPHY gum arabic must perform two critical functions as a densensitizing material on plates and stones. First, the gum arabic when acidified must combine with the fatty acids of the drawing materials and the chemical components of the plate or stone to form grease reservoirs from which the image may be printed; second, the gum arabic must

GRAPH 2

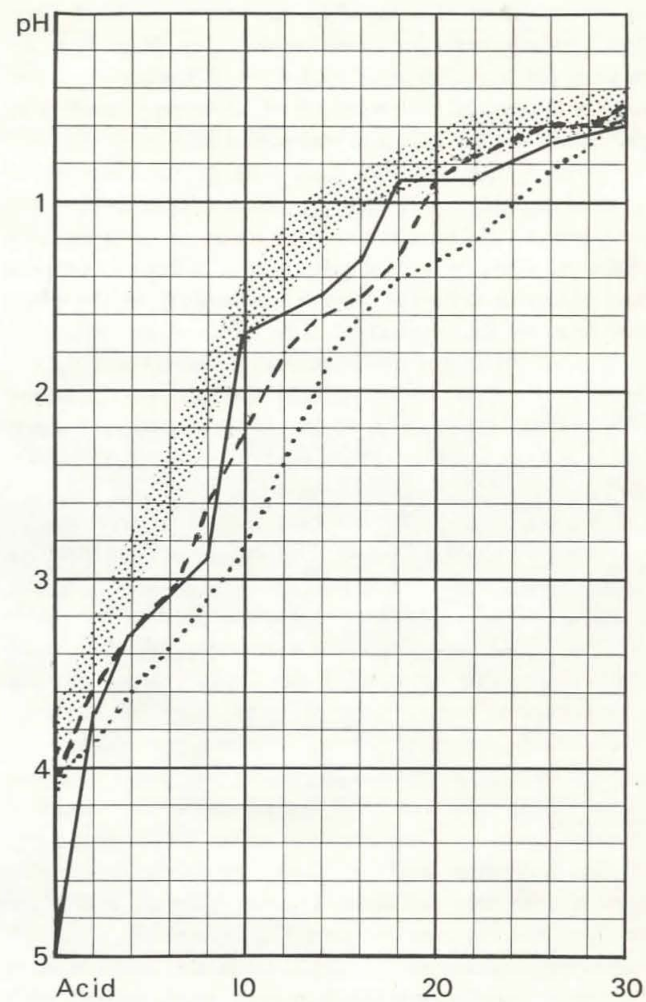


Normal range of gum arabic solutions as derived from **Graph 1.**

Lith-Kem-Ko Kem-rabic solution, product 2437, control 49707 (Nov 74), 14° Baume.

Richgraphic Lovisgum (Nov 74), 14° Baume (pH 5.5 from container).

GRAPH 3



Normal range of gum arabic solutions as derived from **Graph 1.**

Mixture, 50% Hanco gum arabic, MS 587 (F18342) and 50% Hanco cellulose gum, MS 448 (F18147).

Mixture, 50% Richgraphic Lovisgum and 50% Hanco cellulose gum, MS 448 (F18147)

Hanco cellulose gum, MS 448 (F18147)

deposit an adsorbed gum film on the negative areas of the printing element, desensitizing these areas against acceptance of further grease and creating a receptivity to water which would not otherwise be present.

The ability of gum to perform these functions is dependent not only upon its viscosity and density (measured in degrees Baumé) but also upon its response to acidification in small and determinable increments. The etching of stones and plates depends entirely upon the constancy and predictability of acidified gum solutions. Pure gum arabic, as marketed over a long period of time, has permitted such control. Its pH has varied within only a narrow range, and its behavior in etches has been entirely predictable.[3]

Now, however, in response to the high cost of pure gum, a whole new range of gums has entered the marketplace. Some are hydrogum, a natural gum derived from the mesquite plant,[4] some are entirely synthetic, and some are mixtures of gum arabic and synthetic gums.

Tamarind has recently undertaken an extensive series of tests to determine the qualities of certain substitute gums and to assess their suitability for use in hand lithography. The three graphs that accompany this article summarize the data determined through these tests (in all three graphs the horizontal scale represents the acidification of the etch, stated in drops of nitric acid per ounce of gum solution; the vertical scale represents

the pH of the acidified solution).[5] The procedure was as follows: the pH of the gum solution was first tested before addition of acid; then, as acid was added, drop by drop, the tests were repeated (using pHydrion test papers, pH scale 5.5 to 3.0 and, later, pH scale 2.8 to 1.4) until a maximum etch strength of 30 drops of nitric acid per ounce of gum solution was achieved.

Graph 1 indicates that pure gum arabic solutions of normal quality will acidify in a dependable step progression and within a narrow range of variance. The chemical composition of gum arabic is highly complex and varies in different samples according to the place and time of their collection. The effect of this variation is seen in the slight differences in behavior among the two Hanco gum solutions and the one compounded from gum crystals. The acidification of cellulose gum, also shown on this graph, is also predictable, but quite different from that of gum arabic.

Graph 2 shows the normal range of gum arabic solutions as a dotted band. The erratic behavior of the synthetic gums is demonstrated by the fact that they reach a pH of 1.4 and 1.5 after addition of only *four* drops of nitric acid. They are thus impossible to control when the needs of hand lithography require precise formulation of etches in the pH range between 2 and 4.

The acidification pattern of cellulose gum (shown on graphs 1 and 3) suggested the possibility that the erratic character of the synthetic gums might be modified through mixture. Two mixtures were tested, one combining Lovisgum and cellulose, the other combining gum arabic and cellulose. Graph 3 shows that their acidification patterns are generally acceptable, although still somewhat erratic in the case of the mixture with Lovisgum. Unfortunately, however, work etched with these solutions tends to coarsen.[6]

We have reached the following conclusions as a result of these tests:

1. It should be standard practice to test each new gum solution (including each new batch of gum arabic) to determine its acidification pattern before beginning its use in the workshop.

2. Mixtures containing cellulose gum are not suitable for use on stone or aluminum.

3. Synthetic gum solutions cannot be successfully used in formulation of etches for hand lithography.

4. Synthetic gums *can* be used in an unacidified state for certain other purposes, including gum-out masks, wash-out masks and storage masks, and cleaning processes on stone or plates. Economies can be effected through use of synthetic gums for these purposes.

5. While there is a need in hand lithography for a gum solution less expensive than pure gum arabic, there is as yet no substitute which shares its dependable and predictable performance.

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1. See TBL, Section 10.1, pages 281-2.

2. Prinsky, Robert. "Stuff That Makes Gumdrops Gummy Is Costly, Hard to Get." In *The Wall Street Journal,* Tuesday, October 22, 1974.

3. See TBL, Section 2.3, page 59.

4. See TBL, 10.3, page 283.

5. The tests of gum acidification were conducted by Tamarind Printer-Fellow David Salgado.

6. The reasons for this phenomenon are not fully understood, but may be due to the molecular structure of cellulose gum. Although cellulose gum is an excellent material for use on zinc it should never be used on aluminum, either alone or in combination with other gums. Its use leads to oxidation of the plate and to formation of pit-dot scum (tiny pits in the surface which fill with ink during printing). Pit-dot scum is an irreversible and irreparable condition on aluminum.

PEDRARA ONYX

Continued from page 42.

the calcium carbonate is deposited. Though most deposits consist of calcite, the rhombohedral form, others are of Aragonite, the orthorhombic kind. Impurities in the solution, such as oxides of iron and manganese, may vary from time to time during deposition so that successive layers will be of different colors." (Fisher)

"Marble, even the most expensive grades, when placed in an exposed position, soon loses its polish, and becomes stained and streaked with rust, ink, smoke and grease. Once stained, the porous nature of marble causes the discoloration to spread throughout, and it is a well known fact that stains on marble cannot be eradicated. This disadvantage does not appear in Pedrara Onyx, whose texture is so fine that it is practically non-absorbent, and is impervious to stains of any kind. Again, its extremely close grain and great hardness make it susceptible to an enamel-like polish, which it holds longer than any other stone." (Lea)

"The Mexican onyx deposits are the most important commercially at the present time. The quarries, known as the New Pedrara, are at El Marmol, Lower California, 51 miles inland from Santa Catarina, the port of shipment, and about 330 miles southeast of San Diego, Calif. The largest of them are on a mesa about 40 feet high, 3,000 feet long and 1,200 feet wide. Commercial onyx occurs in three beds. The upper one is thin and highly colored. . . . The second bed is 1 to 2 feet thick . . . and the third or lowest stratum supplies large blocks ranging from 1 to 4 feet in thickness that may be cut into sound slabs." (Fisher)

Mr. Hill notes in a letter of March 15, 1975, that "about two years ago another deposit located to the south and west about fifty miles opened and is the current source of our material. José Escudero, the present owner, brings the blocks to San Diego where, with new slabbing equipment, we saw the blocks and cut slabs to the various uses to which onyx is put."

"It is not through her usual caprice that nature chose one of those wild and desolate stretches of desert . . . to produce her most beautiful product. A warm, rainless and dry region is essential to the formation of onyx, for rains which did not entirely wash away the sedimentary deposits which in time form travertine, would wash in foreign matter, making the onyx so full of flakes and flaws as to render it worthless." (Lea)

4. Southwest Onyx & Marble Company, P.O. Box 106, San Diego, California 92112.

5. Data on Solnhofen limestone are derived from TBL, p. 266; data on Pedrara onyx are from Lea, *op. cit.*

6. Stephen Britko, Tamarind Master Printer, is a member of the Tamarind staff. All of the technical data in this article are based on his research. He also conducted the correspondence with Mr. Hill, referred to in note 3 above.