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CLAY REFINING AND GLAZED TILES MANUFACTURE

DP/MAT/75/002

MALTA

TERMINAL REPORT

Prepared for the Government of Malta by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

S. 76-6978

United Nations Development Programme

CLAY REFINING AND GLAZED TILES MANUFACTURE
DP/MAT/75/002

MALTA

Project findings and recommendations

Prepared for the Government of Malta
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Kvetoslav Engelthaler, expert in ceramics technology

United Nations Industrial Development Organization
Vienna, 1976

Explanatory notes

References to dollars ($) are to United States dollars.

The monetary unit of Malta is the Maltese pound (£M). During the period of the present report, the value of the Maltese pound in relation to the United States dollar was $1 = £M 0.43.

The use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

A full stop (.) is used to indicate decimals.

References to "tons" are to metric tons.

In tables, a dash (-) indicates that the amount is nil or negligible.

ABSTRACT

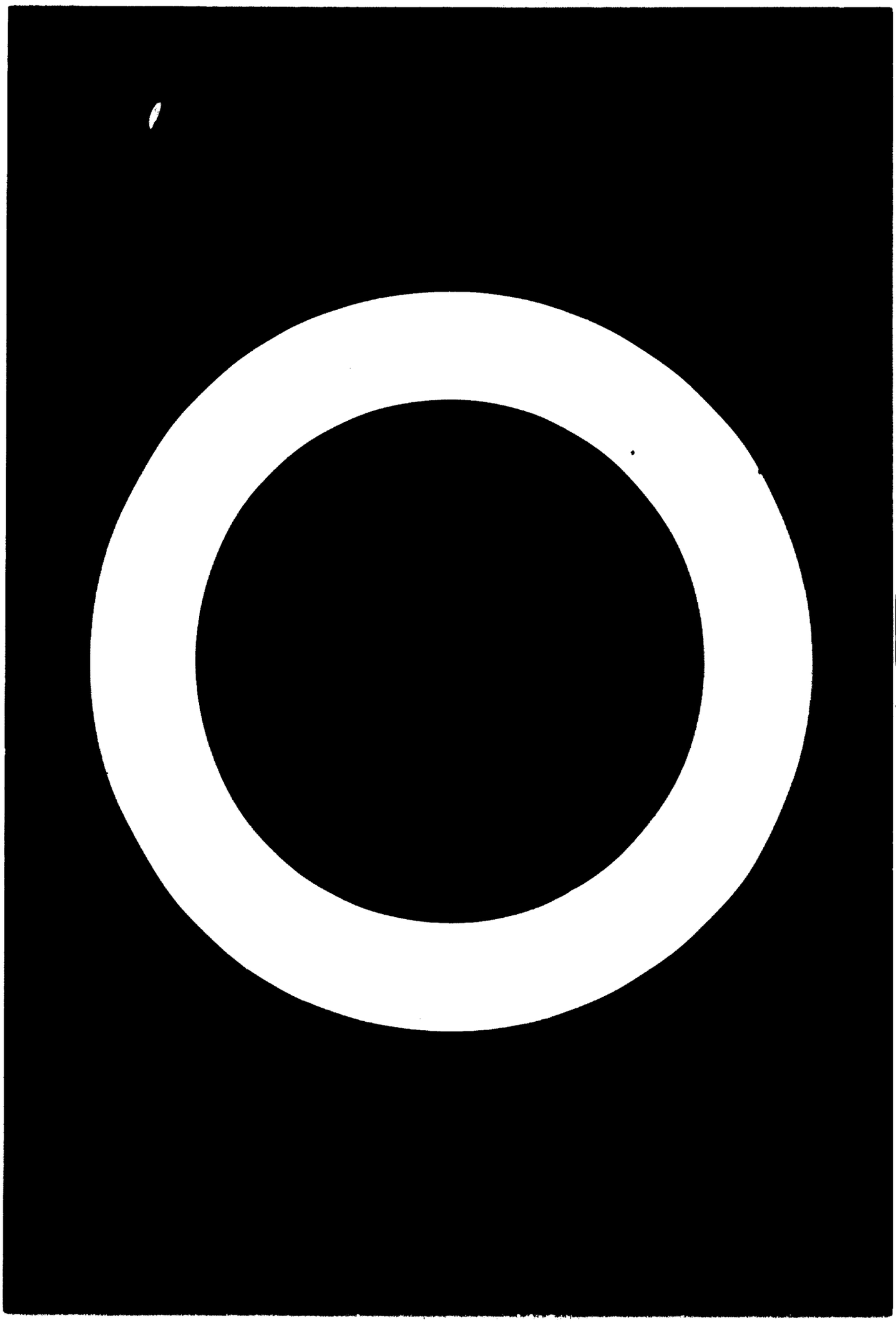
The project "Clay Refining and Glazed Tiles Manufacture" (DP/MAT/75/002) was requested by the Government of Malta in February 1975 to follow up a one-month exploratory mission undertaken in November 1974. Assistance in the amount of $40,680 was provided by the United Nations Development Programme (UNDP), with the United Nations Industrial Development Organization (UNIDO) acting as executing agency. The first part of the project took place in April-June 1975, followed by a further eight months from November 1975 to July 1976. The current report covers the latter part of the project.

The expert in ceramics technology assigned to the project was expected to assist the Government in establishing a pilot plant for the creation of a ceramics industry in Malta. Such an industry would be based on a sizable deposit of blue clay that appears suitable for the production of such items as face bricks and blocks, expanded lightweight aggregates, wall tiles, façade tiles, decorative ceramics, glazed floor tiles and cement.

A clay deposit suitable for mining has been selected, but its size and quality have not yet been determined. Drilling sites have been marked by the expert, but drilling has not yet been done, owing to the unavailability of the only suitable machine on the island. It has thus been impossible to test any core samples, but the testing programme has been discussed with the head of the Standards Laboratory.

A beginning has been made with the establishment of a pilot plant in a hangar provided by the Government at Ta'Qali. Machinery and other equipment of a value of more than $250,000 have already been acquired or are on order, and much of it has been installed. A local expert has been engaged to take charge of the operation, and some staff have been hired. Trial runs of some products have been conducted.

However, the pilot plant still requires expert supervision for at least twelve months. Much money and work have been invested in this programme; it will all be wasted unless appropriate follow-up action is quickly taken.



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INTRODUCTION

The project "Clay Refining and Glazed Tiles Manufacture" (DP/MAT/75/002) was requested by the Government of Malta and executed by the United Nations Industrial Development Organization (UNIDO) for the United Nations Development Programme (UNDP). So far three short-term missions have been undertaken to Malta in connexion with the establishment of a ceramics industry there. The first was a one-month exploratory mission in October 1974. As a result of this mission, it was decided not to begin with the production of lime-sand bricks and sewer pipes, as originally envisioned; the former require, as basic material, quartz sand, which is not available on the island, and the latter would not be profitable to produce in the quantities demanded by the local market. However, it was found that the local blue clay seemed suitable for the production of face bricks and blocks, expanded lightweight aggregates, wall tiles, façade tiles, decorative ceramics, glazed floor tiles and cement, as an addition to the local limestone.

The next mission, the first part of the current project, was intended to obtain further information and took place from April to June 1975.[1/] A clay deposit suitable for mining was selected, and drilling sites were selected. However, the core-drilling was not done owing to the unavailability of the only suitable machine on the island. It was consequently impossible to test any core samples, although the testing programme was discussed with the chief of the Standard Laboratories. A beginning was made with the establishment of a ceramics pilot plant. A hangar at Ta'Qali was provided by the Government to house it. The needed repainting and repairs were under way when the expert left the island in June 1975. The plant layout has been prepared and the building of foundations for the various machines had begun. The Government had already acquired some ceramics machines, among them two blungers, a horizontal vacuum press with a mixer, a glazing machine, a stationary kiln and a tunnel kiln.

1/ The report on this phase of project activities is contained in document UNIDO/ITD.343 of 3 July 1975, also entitled "Clay refining and glazed tiles manufacture".

Then, in response to a further request from the Government, the project was extended for approximately eight more months, from November 1975 to July 1976. The purpose of this phase of the project was to assist the Government to establish a pilot ceramics plant to produce glazed mosaic tiles, decorated glazed wall tiles and the like and ready-mixed ceramic bodies for local craftsmen. Specifically, the expert was to:

Start the production of glazed mosaic tiles and help to overcome the initial problems

Assist in re-equipping the pilot plant, including the installation of newly ordered items

Advise in core drilling at the selected sites at the clay deposit at Dwejra, evaluate the laboratory-tested core samples and calculate the total industrial reserves of clay for future production

Advise in the chemical testing of the core samples which is expected to be done by the Standard Laboratories, which is part of the Department of Industry

Begin with the production of glazed, decorated wall tiles and evaluate the large-scale trials with a view to larger-scale industrial manufacture

Supervise production trials in the pilot plant on flower pots, decorative fence blocks and glazed and unglazed façade tiles, and evaluation of these articles

Assist in the possible follow-up projects to assist the Government of Malta to establish a large-scale ceramics industry

Most of these tasks were accomplished, but some could not be, as discussed in the following sections of the present report.

I. FINDINGS

Re-equipment of the pilot plant, including installation of available equipment

All of the machines and equipment that were available locally were transferred to the newly repaired hangar at Ta'Qali. Foundations for the mixer, vacuum horizontal press, both mosaic and wall-tiles presses as well as for the edge-runner mill were erected. Foundations for two filter presses had not been erected by the end of this project, because the bearers holding the cake-pressing frames (moulds) were still missing and the membrane pump for slurry transport from the agitators to the presses was not yet available. Except for these two items and the belt conveyors, the pilot plant was complete; all other necessary equipment was either present or on order. The mosaic and wall-tiles presses and the edge-runner mill ordered from Pragoinvest (Czechoslovakia) arrived at the beginning of March and were put in operation and tested in the production trials. The ball mill for the fine milling of body mixtures was ordered at the end of January 1976. Delivery time is four to five months, so it should arrive in Malta in June or July. The ball mill must be lined with the silex bricks that will be supplied with it before it is put in operation. Also, concrete foundations will probably be necessary to adjust the ball mill to the proper height in order to allow the slurry a sufficient slope down to the agitator, whence it will be pumped to the filter presses. The expert evaluated three different tenders and recommended the Constanze ball mill from Dorst, in the Federal Republic of Germany, the sizes of which are 1,600 x 1,420 mm and the operating capacity 650 kg of quartz per day.

For the installation of the machines and available equipment the pilot plant layout previously prepared by the expert was used. There were only small changes; the most important one was that the two presses were erected closer to the edge-runner mill in order to be connected directly with a belt conveyor.

The external power supply has been brought to the room where the main switchboard and electricity meter are located. From there starts the internal power distribution to the individual machines and kilns. This location for the electricity input was chosen because it provides the

shortest way to the main power consumers, namely the electric tunnel and stationary kilns and the vacuum horizontal press. The external power supply was finished in early April, and the internal power distribution was nearly finished when the expert left the island.

However, the pilot plant was practically erected and ready to start the production of mosaic tiles and vacuum-pugged items. For the production of glazed decorated wall tiles it is still necessary to erect the ball mill, both filter presses and the slurry pump, but both agitators, the edge-runner mill, the glazing machine and the kilns are ready.

It should be mentioned that the pilot plant will also need a weighing scale with a capacity up to 100 kg and small silos above the presses as well as a small laboratory equipped for simple tests, as of humidity, water absorption, sieve analysis, measurements, firing of samples up to 1,150°C and body preparation in laboratory pot mills (annex I). The more complicated tests such as chemical analysis should be done by the Standard Laboratories.

Selection of the labour force

A critical problem was to find a qualified local person to head the project. In January 1976, one was selected and appointed (annex II). This person has the degree of Bachelor of Arts (industrial and artistic ceramics) awarded by a technical school in the United Kingdom and good experience in the mixing of glazes and their application to ceramic bodies. Unfortunately, he has no experience in the industrial production of ceramics, body compositions or industrial economy, so the expert began to train him in these areas. Under the guidance of the expert, he has performed all the tests with the glazes and stains in the Standard Laboratories, using local biscuit body.

The other staff requirements for the pilot plant are still unclear, since it is not yet in operation. Two young women, graduates of the School of Crafts at Targa-Gap, were selected for the production of mosaic tiles (glazing and pasting on mosaic sheets), but one of them soon resigned. Five men from the Pioneer Corps were selected for the pilot plant, but three of them also resigned, claiming that they were skilled craftsmen (electricians or plumbers), and would not work as labourers in the ceramics plant. Three other labourers were employed shortly before the expert left the island. It must be understood that four carefully selected and reliable men will be required to operate the tunnel kiln on a shift basis. Seventeen other workers, six of whom could be women, could also be employed.

Production trials

The external power line for the pilot plant was finished in early April 1976, and the internal power distribution was nearly completed when the expert left the island. Therefore only a few production trials had been conducted and these only in limited amounts.

As far as the mosaic tiles are concerned, the blue clay was milled in the edge-runner mill and screened below 2 mm and stored in an improvised bin. About 10 m^2 of mosaic tiles (20 x 20 mm) were pressed on the mosaic press with adjusted pressure to 200 kg/cm^2. After drying, the mosaic tiles were fired in refractory boxes in the stationary kiln to 1,020°C. More exactly, the temperature was judged from the temperature when the Seger cone 08a (960°C) melted and from the temperature shown on the pyrometer. However, the pyrometer did not show the correct temperature in the kiln because it had not been connected with the thermocouple with the proper compensation wire. Nevertheless, it would appear that the temperature was 1,020°C or very close to it.

After biscuit firing, the mosaic tiles were glazed with a spray gun, using glazes supplied as samples. After glazing, the mosaic tiles were fired to the temperature 950°C. However, the temperature in the kiln was, for the same reason, slightly too low, so some of the glazes were not properly melted.

Evaluation of the mosaic tiles trial could be done only visually, because laboratory facilities are not yet available. After firing, the porosity of the mosaic tiles seems to be within the international limits, that is, between 14 and 24 per cent, and seems to be closer to the higher limit. Also the strength of rupture of green tiles as well as of fired ones is excellent. Tile shrinkage from the pressed to the dried state is 2 per cent only, which is very suitable. The tested glazes suit the body in spite of the fact that, in the first trial, many pinholes were found, and some glazes were not properly melted, as mentioned above.

As for glazed wall tiles, the expert prepared about 8 kg of wall-tiles body mixture at the Malta Crafts School at Targa-Gap for the pressing trials on the newly erected presses. For the body composition, the local clay, and grog prepared from rejected wall tiles and finely ground quartz imported from Italy were used.

The body was milled in the laboratory pot mills (1 kg of raw materials per charge) and de-watered by soaking excess water through rejected filter press cotton sheets and by natural drying up to the body moisture 4 per cent. By hand crushing and screening below 2 mm, a suitable pressing powder was prepared. The 150 x 150 mm tiles were compacted with a pressure adjusted to 280 kg/cm^2. After drying, the tiles were fired to the temperature 1,020°C with the same difficulties as the mosaic tiles, because they were fired together. The tiles were without warpage. Glazed with the same glazes as the mosaic tiles and glost fired to the temperature 950°C, it was realized that the glazes suit the body and that the coefficient of thermal expansion (CTE) of the wall tiles body seems to be very close to that of the used glazes, because the wall tiles showed no warpage after firing.

However, more production trials for both products will be needed before the pilot plant can be brought into full production. Special attention should be given to the manner of loading the tiles, the range of moisture of the pressing powder, the optimal biscuit and glost firing curves and temperatures, the optimum amount of glaze per tile and the Harkort test.

Training local staff

As noted earlier, the pilot plant was not in full operation when the expert left the island. However, the expert had had the opportunity to explain theoretically to his local counterparts as well as to other staff members the principles of each available machine: how they are fed, how they operate and what faults should be avoided in production. Special attention was given to the presses, which are the most complex machines in the factory. It was explained how to fill the presses with nitrogen, where and how to oil the gearboxes, how to adjust the correct pressure (280 kg/cm^2) when the tiles are pressed, how often to clean the dies etc. Because in Malta there is a large turnover of the labour force, two workers, as well as the local expert, were instructed how to operate these two presses.

A key item of the equipment of the pilot plant is the tunnel kiln. The staff was instructed how to repair its bottom, primarily at the junction, because it had been dismantled into three sections for transport. If it were put into operation without such a repair, the slabs, with saggers and goods, would

destroy its bottom completely as they were pushed along, and a new lining of shaped refractory bricks would have to be ordered from the supplier in Italy, and the kiln would have to be completely relined. This would represent a waste of both money and time. A quantity of mortar suitable for such a repair is in the hands of the local expert.

The glazing machine, which is actually a line of many single-purpose machines, should not be cemented down before a test run of one or two days has been conducted. All of the operations which may be expected to be performed on the glazing machine were explained theoretically to the staff, and some of them were demonstrated practically.

While actual work with the equipment would have been the best way to teach the staff of the pilot plant, it was not possible to operate the machines, since the internal power distribution system had not been completed before the departure of the expert. (In Malta, as in many other countries, internal power installations must be completed and tested for safety before the Electricity Board will allow them to be connected to the power mains.)

Together with his local counterpart, the expert prepared about 8 kg of wall-tile body on the laboratory equipment of the Malta Crafts School at Targa-Gap. This practical training has given the local counterpart a clear understanding of how to prepare the body for mass production when the ball mill has been delivered and installed and the slurry pump and the two filter presses are in operation.

The local counterpart was also successfully trained to test quartz sand for its SiO_2 content in the Standard Laboratories. He also completed tests, under the guidance of the expert, with locally available glazes, using biscuit body composed of local raw materials. The final evaluation of the results was also done together with the expert.

The local counterpart was also present in the pilot plant during the installation of the machines; during their erection, he was instructed in their operation. He was also taught the basic performance faults of the individual machines and what should be avoided to produce a successful result.

Establishing a ceramics industry in Malta

There is very much that must be done before there can be any large-scale production of ceramics in Malta. Before any decision is taken to establish such an industry, the four following tasks must be fulfilled:

(a) Performance of core drilling in the selected deposit of blue clay. Drilling should be done at the sites indicated by the expert in April 1975. If possible, the drills should penetrate to the base of the clay deposit;

(b) Transfer of the clay samples obtained by core drilling to the Standard Laboratories, which are fully equipped to perform the necessary chemical, mechanical and technological testing, and test them for chemical analysis, wet-dry shrinkage, dry-fired (1,000°C) shrinkage, porosity after firing and residue on the screen (10,000 openings/cm^2). According to the results obtained, the quality of the clay deposit as industrial reserves for a minimum of 20 years should be determined, since the existence of reserves of raw materials is a prerequisite, not only for the establishment of any large-scale ceramics industry in Malta but also for the large-scale tests and production in the pilot plant. The core-drilling machine which is suitable for this job has been promised several times and was once transferred briefly to the clay deposit, but drilling has not yet begun;

(c) Put the pilot plant into full operation, perform several large-scale trials in the production of glazed decorated wall tiles, mosaic tiles, flower pots, decorative fence blocks and façade tiles. Evaluate all of the large-scale trials from the technical, economic, and marketing points of view and decide whether the products would be competitive on the world market. It should be borne in mind that Malta itself, being a small country with only 320,000 innabitants must, if any large-scale ceramics industry is to be established, rely on exports, preferably to the Libyan Arab Republic and other countries of North Africa and Western Asia;

(d) Test the local clay abroad. While it might appear useless to make large-scale trials abroad when these tests will be done in the pilot plant, it should be stressed that the pilot plant can perform large-scale trials only within the technical parameters of its machinery and equipment. The possibilities for testing are especially limited in the firing section; the tunnel kiln has a maximum temperature of 1,000°C and a production temperature range of 960° to 980°C, which is adequate for glost firing with suitable glazes but definitely not for biscuit firing, in which the temperatures are usually in the range of 1,050° to 1,080°C. The large-scale trials are expected to be done in a factory in another country that would have better facilities than the pilot plant. Also, comparison of items made in the pilot plant with similar ones made elsewhere would be of considerable interest.

Unless all four of these tasks are fulfilled, no decision can be made about the viability of a Maltese ceramics industry on an industrial scale. It is most regrettable that, in Malta, it seems to be generally believed that a ceramics industry would be very simple, like other small-scale industries and crafts that already exist. For example, no one seems to be aware that variations in the SiO_2 content of the wall-tiles body will change the relation of the biscuit to the glaze, and that the tiles will start to warp and their sizes to become irregular and therefore unusable, or that tension in the tiles may cause crazing and eggshelling of the glaze.

Further assistance required

It appears that it would be very difficult for the Maltese authorities to fulfil the four tasks enumerated above or to arrive at any further decisions in this area without external assistance. The pilot plant itself would require such assistance for at least twelve months. Furthermore, the estimation of the extent and quality of the industrial reserves of clay is not simple; it must be done by a qualified individual.

The expert would like to stress that a twelve-month follow-up mission would be needed; it would be useless to send short-term experts to this project. To start production in, for example, the tunnel kiln, it would be necessary to arrange continuous production around the clock, through working days, week-ends and holidays, without interruption. This kind of thing cannot be done on a short-term basis.

Other activities of the expert

In addition to these described in the previous chapters, some further activities of the expert were the following:

(a) A visit to a small workshop at Bugibba where flower pots are produced from local clay by throwing. The method of production is very simple: blue clay is wetted and mixed by hand to a plastic body with a moisture of approximately 28 to 30 per cent. After ageing for 24 to 48 hours, bulks of about 10 kg are prepared and dried to the stage at which throwing is possible (moisture about 24 to 26 per cent). Sixty pots, 10 to 12 inches (25 to 30 cm) in diameter, are produced daily in the green stage by three workers, throwing being done in the morning and preparation of the plastic body in the afternoon. After drying, the pots are fired in a very old and primitive wood-fired kiln to a temperature of about 750°C. There are about 20 per cent rejections after firing, usually because of cracks.

It would seem advisable to transfer this production to the pilot plant and replace hand body preparation, which is labour intensive, by pugmill body preparation in the factory. Another possible advantage is that the quality of the body might be improved by the addition of grog so as to reduce the percentage of rejections. Also, production would double when the time previously used for body preparation is used for throwing. The only disadvantage is that, if a new kiln fired with diesel oil were to be built in the pilot plant, throwing might be replaced in future by pressing. The Government of Malta is considering the purchase of a suitable press for flower pots production that could very easily cover the annual demand for flower pots (120,000 pieces of various sizes) on the island;

(b) Before the order for a ball mill was placed with a firm in the Federal Republic of Germany, the expert also evaluated quotations received from two British enterprises. The advantages and disadvantages of these ball mills were carefully weighed and, despite the fact that a British one had a ready-fixed silex lining, the difference in price did not correspond to this advantage. The Constanze ball mill was therefore recommended. Its daily capacity is 650 kg of quartz, which corresponds to approximately 550 kg of calcined clay, which in turn is equivalent to 1 ton of wall-tiles body per day. This capacity will safely cover the production of wall tiles in the pilot plant;

(c) During the preparation of the national project for the pilot plant, the expert assisted and advised the specialist on the distribution of power not only for the existing machines but also for those that were on order. The power distribution system was being installed according to this approved project towards the end of expert's appointment;

(d) All the existing machines and equipment except the filter presses were installed and some of them supplied with power. The expert recommended the connexion of some machines, such as the mill and the presses or the mill and the mixer above the vacuum horizontal press, with a rubber belt conveyor in order to reduce the labour to a minimum. It was also calculated that the belt conveyors should not be steeper than 16°. The expert discussed these matters with the local supplier of belt conveyors;

(e) Some other activities of the expert should be mentioned briefly. They include:

Discussions with representative of the Swedish Industrial Development Authority (SIDA) regarding possible future collaboration

Discussion with a Bahraini delegation regarding possible export of tiles

Occasional discussions with the Minister of Trade, Industry and Tourism

Discussions with the Director of Industry

Discussions with local craftsmen

Checking of availability of nitrogen necessary for filling the tile presses etc.

II. CONCLUSIONS

The findings of the expert during his third assignment in Malta may be summarized as follows:

(a) The core drilling has not yet been done, despite the fact that a good knowledge of raw materials used in production is the prerequisite. The Ministry of Industry had been unable to persuade the Public Works Department, which owns the drilling machine, to lend it for the approximately three weeks that would be required;

(b) Tests of drilled samples and the evaluation of the clay deposit could not be carried out. It is to be mentioned once again that the Standard Laboratories are fully equipped to make all the necessary tests according to the International Organization for Standardization (ISO). Evaluation should be done by an expert;

(c) The machines which were erected in the pilot plant up to now would permit a start to be made with the production of mosaic tiles. A rubber belt conveyor should be added to transport milled body from the edge-runner mill to the presses. but otherwise everything is ready; the presses, an edge-runner mill, a stationary kiln for biscuit firing, a glazing machine and a tunnel kiln for glost firing all exist. However, the sheets of 30 x 30 cm double-gummed paper used for pasting small mosaic have yet to be supplied;

(d) In addition to the machines used to produce mosaic tiles, the following machines will be needed to produce glazed decorative tiles:

A ball mill (one is on order from the Federal Republic of Germany, delivery in June or July 1976)

Two blungers (one for the clay, the other to mix the body composition of clay and grog slurry - already erected)

Filter presses (The existing ones lack the bearers that hold the round frames. These are obtainable from Italy, but delivery time is not known.)

A vibrating screen (The existing one lacks the frames that hold the screens. These have been broken or lost during several shipments from Italy. Delivery time is not known.)

A membrane pump (The one that had been ordered was lost in transit, and a new one has not yet been ordered. According to the tenders, delivery time from Czechoslovakia would be 18 months, and from Italy, three to four months.)

(e) The production trials of pugged items such as façade tiles and decorative fence blocks can start very soon with the existing machinery. The only equipment that is still missing is the belt conveyor that is expected to supply the mixer above the vacuum press with the ground material. The pugged body can be also used for the production of flower pots;

(f) The equipment needed for the production of wall tiles includes all that would be necessary to produce clay for local craftsmen. Consequently, many of the machines needed are still incomplete or missing. (See (d) above.);

(g) The ball mill will be supplied with a loose silex lining that must be installed on the spot. This work should be done very carefully so as to ensure as long a life of the mill as possible;

(h) For production, a weighing scale with a capacity up to 100 kg is necessary. It would be used when the components are charged to the ball mill to secure the prescribed body composition. It should be also used to charge glaze powders when the glaze mixtures are prepared. It will also be necessary when the ready-mixed body is sold to local craftsmen;

(i) It would be advisable to establish a small and simple laboratory that would be able to test moisture, water absorption, shrinkage, sieve analysis, testing of glazes and testing of body mixtures. The equipment necessary for such testing is listed in annex I;

(j) The pilot plant has no artificial drier; only the natural drying of clay, filter-pressed cakes and all other products is expected. Consequently, the local clay should be supplied at least three months in advance (five to six months would be preferable), especially during the rainy season and in winter, in order to reduce its natural moisture of approximately 12 to 14 per cent to a minimum of 3.5 per cent before it is used. This clay is very plastic and its natural humidity is therefore very high, and it takes a long time to dry;

(k) Some of the workers selected to work in the pilot plant would not accept jobs as labourers and resigned, claiming that they were skilled in various trades. Despite the fact that Malta has about 3,500 unemployed, it appears difficult to find workers willing to work on a sliding-shift basis;

(l) The external power supply, which has a 250-kilowatt transformer, was ready early in April 1976. However, the internal power-distribution system had not yet been completed; another month of work appeared to be needed;

(m) Five different bodies for the production of tiles and flower pots, as well as two bodies for the use of craftsmen, were worked out from the theoretical point of view. They are considered in some detail in chapter III, "Recommendations".

III. RECOMMENDATIONS

Ready-mixed ceramic bodies

It is recommended that the pilot plant produce the five different ceramic bodies shown in table 1.

Table 1. Composition (per cent) of five ceramic bodies to be produced by the pilot plant

Raw materials	Glazed wall-tiles body	Mosaic tiles body	Flower pots body	Normal body for craftsmen	Special body for craftsmen
Green blue clay	45	100	66	60	45
Grog fired to 950°C	-	-	34	40	35
Grog fired to 1,050°C	28	-	-	-	-
Quartz[a/]	27	-	-	-	20
Total	100	100	100	100	100

[a/] Minimum SiO_2 content, 98 per cent.

Glazed wall-tiles body

This body can be prepared in two different ways. Both methods should be tested and the better one selected. The first method is to blunge the clay in the upper blunger and pass it through the vibrating screen when it is transferred to the lower one. Meanwhile, the grog and the quartz (or quartz sand) are milled with an equal amount of pebbles and water in the ball mill until the residue on a screen of 10,000 openings/cm^2 is less than 8 per cent. When the grain size of the ball-milled slurry corresponds to the given figure, it is discharged into the lower blunger and mixed with the blunged clay for 30 minutes, filter pressed, the cakes dried to 3.5 to 4 per cent moisture and milled in the edge-runner mill to below 2-mm particle size to make the pressing powder.

The second method is simpler because all of the materials, including the green clay, are charged into the ball mill and milled until the residue on a screen of 10,000 openings/cm^2 is less than 8 per cent. Further operations are

the same as in the first method, namely, discharging into the lower blunger, filter-pressing, cake drying and milling below 20-mm partiole size to the pressing powder.

From the economic standpoint, the first method appears to be the better, since the pilot plant (or, more precisely, the ball mill) can prepare nearly 1 ton of pressing powder daily, while the second method permits the preparation of only 500 kg of it in the same time. However, only the final results with the fired glazed tiles can determine which method should be selected.

Mosaic tiles body

This material is prepared from dry (moisture only about 4 per cent) green clay, milled below 2-mm particle size in the edge-runner mill.

Flower pots body

This material should be prepared by ordinary milling of dry green olay and the grog in the edge-runner mill or another suitable machine. As shown in table 1, the green-clay-grog ratio should be 2 to 1. The milled mixture should be charged continuously into the mixer above the horizontal vacuum press, where a sufficient amount of water is added. The body falls from the mixer to vacuum press, where it is pugged into bulks, whioh are used for either throwing or pressing flower pots. The moisture of the bulks for pressing should be in the range of 16 to 20 per oent; that of the bulks for throwing should be in the range of 24 to 26 per oent.

Normal body for local oraftsmen

Dry green clay (or clay recalculated to the dry state) is weighed and blunged in the upper blunger with about three times as much water for at least 6 hours. Since the capacity of the Constanze ball mill is expected to be 500 kg per charge (which corresponds to 650 kg of quartz), the weight of the dry green clay should be 750 kg. After blunging, the clay should be passed through the vibrating screen when returned to the lower blunger. Next, 500 kg of the proper grog should be charged into the ball mill together with 500 kg of pebbles and 500 litres of water and milled for 8 to 10 hours. Before being charged, the grog must be crushed below 2-mm particle size. The milled grog is then discharged from the ball mill to the lower blunger and mixed with the blunged clay for about 30 minutes. The slurry is then ready for filter pressing. The cakes from the filter press, whioh will have a moisture content of about 18 per oent, may be supplied to looal oraftsmen for their use.

Special body for craftsmen

This material is prepared in much the same way as the normal body described above. As shown in table 1, it contains 20 per cent quartz, and the proportions of green clay and grog are reduced.

Bringing the industrial ceramics project to fruition

Completion of the pilot plant

Although the pilot plant is practically ready to perform some of the large-scale production trials, it appears that activities directed towards the establishment of a ceramics industry in Malta are about to be suspended. This would be a great pity, since much effort and money have been put into it. Its present value exceeds $250,000 (table 2). The prime recommendation of the expert is therefore that funds be sought for the continuation of the project, which would otherwise lie idle without being used to help industrialize the country.

Table 2. Value of the ceramics pilot plant at Ta'Qali

Item	Actual value ($US)	Cost to Government (£M)
Machinery available locally	172 357	8 500
Presses and edge-runner mill	55 000	8 500
Ball mill, slurry pump etc.	14 000	5 500
Power installation - internal and external	12 500	5 000
Building	7 500	3 000
Total	261 357	30 500

Some way should be found to help the Government of Malta to bring the pilot plant into operation. For this, the services of an expert would be required for 12 months; any shorter-term project would be insuffioient to secure continuity in future production. The sum of $8,000 should also be found to permit the checking, abroad, of various methods of producing wall tiles so that the best one may be selected.

The local counterpart

The person selected to head the pilot plant has both education and experience in ceramics. However, as noted earlier, he would benefit from a few years of training under a skilled industrial ceramist. After such training he would be the most suitable person to assume full responsibility for the production of ceramics in Malta. An excellent beginning in this direction would be the award of a scholarship for two years so that he would be able to acquire the degree of Master of Science in ceramics. He should also receive special instruction in the training of the workforce.

The labour force

Particular care and attention should be given to the selection of the four workers who would operate the tunnel kiln. As noted, these workers must not only be reliable but they must be able and willing to work on a sliding-shift basis, since firing will be continuous, through week-ends and holidays. Consequently, each of these workers must be prepared to remain on duty at the kiln until he is relieved. Also, these workers must be capable of precise work, since they must ensure the proper timing of the movement of the tiles through the kiln and checking the firing curves and temperatures. It will not be easy to find high-quality people to fill these posts because the Pioneer Corps offers workers ways to earn money that are less demanding in terms of effort and responsibility.

The clay deposit

As quickly as possible, core drilling in the selected clay deposit at Dwejra should be begun. The drilled samples should be transferred immediately to the Standard Laboratories for chemical and technological testing. The value of the deposit as an industrial reserve should be assessed according to

the results of such testing. Provision should be made to supply the pilot plant with sufficient clay for its operation early enough for it to dry in storage to a moisture content of no more than 3.5 per oent. This arrangement is necessary because the plant has no artificial drier.

Equipment

Upon its delivery, the ball mill should be erected and its silex lining installed. Also, the production line for wall tiles should be completed by providing it with a slurry pump, replacing the broken screen frames in the vibrator screen and supplying the missing filter-press bearers that hold the cake-pressing frames. Belt conveyors and a weighing scale with a capacity of up to 100 kg are also needed. The internal power distribution system of the pilot plant should be completed. Only about one more month of work appears to be required.

Laboratory facilities

A simple laboratory equipped with the items listed in annex 1 should be set up in the pilot plant. This laboratory should be able to perform the tests during production. More complicated tests should be performed by the Standard Laboratories; the results should be evaluated by a qualified person.

Final comment

Much money and effort have been invested in this project to establish an industrial ceramics industry in Malta. The value of the pilot plant alone exceeds $250,000. All of this will be wasted unless appropriate action is quickly taken.

Annex I

EQUIPMENT RECOMMENDED FOR THE LABORATORY OF THE PILOT PLANT[a/]

Number	Item
1	Set of screens with the following openings per square centimetre: 16 000 1 600 100; 10 000 900 25; 4 900 400 9
1	Speed moisture tester with 20 boxes of calcium carbide (Ca_2C)
1	Drying oven (up to 180°C)
1	Scale balance (up to 1 000 g)
1	Pharmaceutical balance (up to 100 g), with weights of 0.1-g sensitivity
20	Pieces of laboratory glassware (beakers, bowls, watch-glasses and the like)
1	Desiccator (diameter approximately 20 cm)
2	Plastic pots (about 2-litre capacity each)
2	Metal cooking pots (about 5-litre capacity each)
1	Electric hot plate
1	Laboratory kiln with a firing-programme control up to 1 300°C
1	Andreasen apparatus for particle-size testing
1	Laboratory ball mill (such as the Dorst type TOM 1/90) with 4 porcelain pots (capacities of 3 and 5 litres) and pebbles
1	Cutting saw for sample preparation, with 20 spare cutting discs

[a/] All items that are not available locally should be ordered from abroad as soon as possible.

Annex II

PROJECT LEADERS

Name	Title	Dates of service
Kvetoslav Engelthaler	Expert in ceramic technology	24 November 1975 to 31 July 1976
Paul Haber	Local counterpart	12 January 1976 to date

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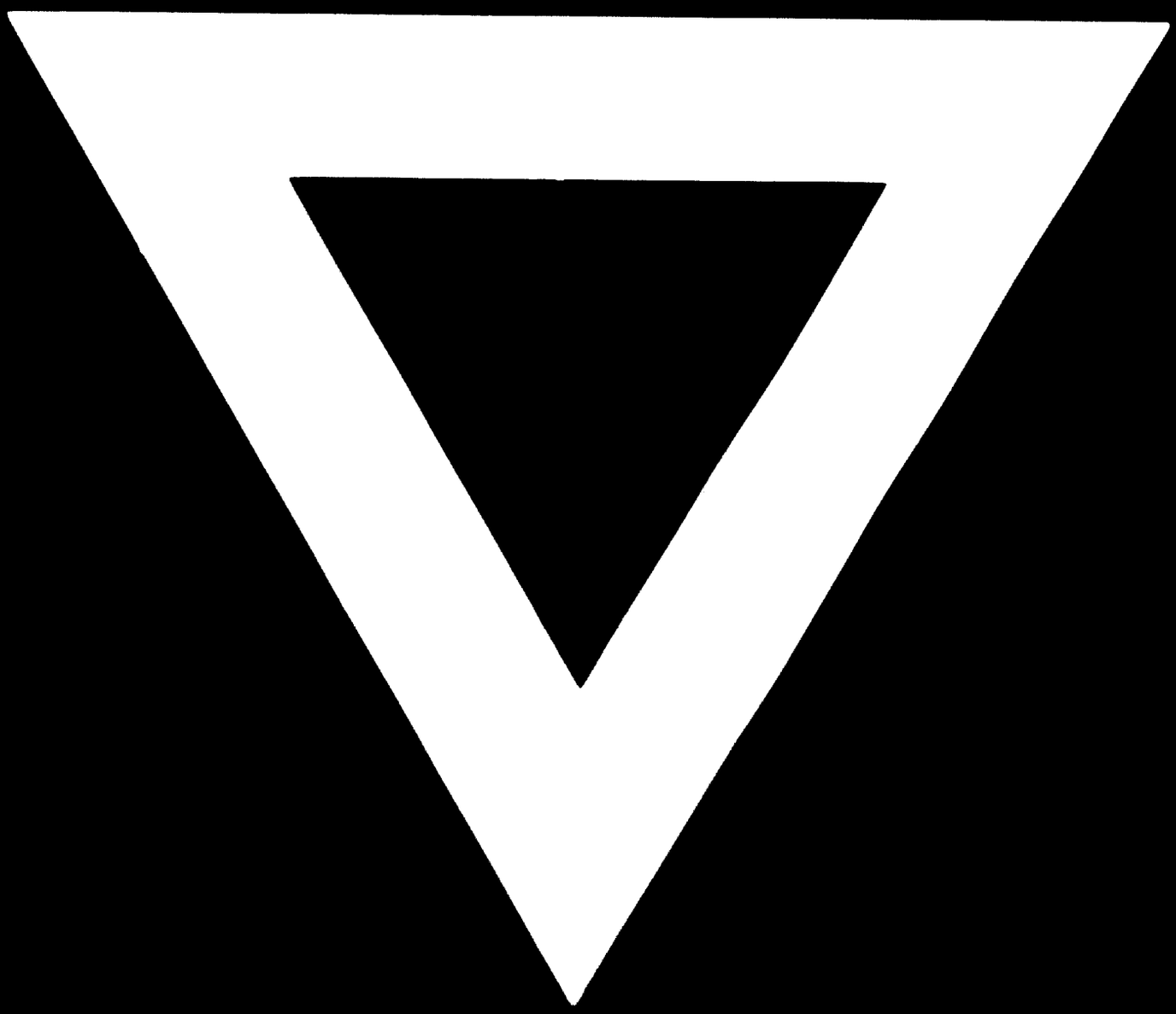

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