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**WORKING GROUP No. 5**

**APPROPRIATE TECHNOLOGY  
FOR THE PRODUCTION OF CEMENT  
AND BUILDING MATERIALS**

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**THE ROLE OF NATIONAL INSTITUTIONS AND  
RAW MATERIALS PROBLEMS IN BUILDING MATERIALS INDUSTRIES**  
Background Paper

THE ROLE OF NATIONAL INSTITUTIONS AND  
RAW MATERIALS PROBLEMS IN BUILDING MATERIALS INDUSTRIES

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ABSTRACT

A common problem affecting the development of building materials and construction industries in developing countries is the lack of adequate expertise and laboratory facilities for the evaluation of suitable deposits of raw materials. Industries producing or consuming non-metallic rocks and minerals usually cannot themselves afford to deal with the particular technical problems relating to these materials. Governments have the choice of either establishing a specialist institute to provide the service required by the industries in the non-metallic sector, or to ensure that the related activities of any existing institutions in this field are co-ordinated as, for example, has been done recently in one country in South-East Asia.

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## 1. INTRODUCTION

The low value-to-volume ratio of both the raw materials and the products of building materials manufacture and, hence, the high transport cost element in overall costs makes it essential that there be careful evaluation of the available raw materials sources, as well as markets, before the final decision is taken to establish a new plant for building material production.

Frequently, developing countries are importing non-metallic mineral products in general, including some building materials, when there exist suitable deposits for establishing local production. This and the problems in newly created building material factories are mostly due to the lack of sufficient national specialists in this field and of the appropriate facilities for evaluating and selecting the most suitable raw materials deposits to use. It applies particularly to clays for brick, tile and pipe manufacture and also to limestones for cement or lime production as well as sands for glassmaking, foundries, etc.

The problem is especially marked in those countries having established petroleum or metalliferous mining industries with, as a consequence, well founded geological and mining institutions to support them. Within these institutions there are, in general, few people or facilities for dealing with the many and diverse problems and requirements of the non-metallic sector.

However, there are indications that governments are becoming aware of the situation and taking action to ensure

that there is the proper development of the indigenous deposits of non-metallic rocks and minerals to supply, amongst others, the ceramic and building materials producers.

An example of recent action taken in one South-East Asian country to co-ordinate the work of all the institutions concerned will be given in this paper. It may act as a model for other developing countries or regions and, as such, should, perhaps, be promoted through the programme for Technical Co-operation between Developing Countries (TCDC).

This paper stresses the responsibility that rests with governments to ensure that trained staff and adequate central surveying and testing facilities are available. These should serve the numerous small producers and consumers of non-metallic rocks and minerals who, otherwise, cannot afford to employ their own specialists or consultants.

## 2. ASPECTS OF THE RAW MATERIALS PROBLEM

The reasons for the common neglect of the non-metallic sector are fairly well known. The value of the non-metallic or industrial rock and mineral production is often only a small proportion of the value of the total production of the mining industry, for example, only 4% in Peru. In addition, the companies working in the non-metallic sector, such as the refractories producers, glassmakers, etc., are not usually sufficiently wealthy to attract qualified geologists and mining engineers as do the big copper or nickel mining concerns.

The typical situation that has arisen in such countries



is as follows. As the currency earned from the export of oil, metalliferous ores and other products is directed through to the development of industry, so the national demand for refined industrial minerals and non-metallic products, such as building materials, increases. Local producers find it very difficult to compete in their own national market. This is because the national consumers, such as, for example, the cement and lime companies who need refractories, are reluctant to switch from the assured quality, but expensive, imported product to the less certain supply from small national producers. Without large orders the companies in the non-metallic sector are unable to invest in modernizing and expanding their operations. They tend to remain relatively small and specialized and require financial and technical assistance if they are to keep pace with the process of overall industrialization. If such aid is not provided, the Government will find that it is having to pay back to the industrialized countries an increasingly large proportion of its export earnings for purchase of refined industrial minerals, such as china clay, and building materials, e.g. sanitary ware, white Portland cement, refractories, etc.

The production nationally of such materials is often possible from indigenous deposits which remain undeveloped for lack of a programme of exploration and evaluation.

Another problem rests in the overall administration of the non-metallic mining sector and the industries based on raw materials from it. Whereas mining and processes for

upgrading non-metallic rocks and minerals lies within the mining sector, their utilization is an industrial activity. Hence the building materials producers, such as lime and brick makers, are operating within two ministerial sectors. Sometimes the small-scale mining of non-metallics is a responsibility of the local office of the Ministry of Home Affairs. Consequently, the planning of a new building materials factory based on local raw materials can require negotiations with several government departments.

### 3. TECHNICAL INSTITUTES AND THEIR SERVICE TO INDUSTRY

There is one problem in particular that tends to occur even quite soon after the establishment of a national laboratory serving, for example, the building materials industry or a branch of it. The emphasis of the work and the purchase of equipment becomes directed towards 'research' or to fields of academic interest whereas the national interest calls for an efficient service of testing and development tailored to the needs of industry. Part of the problem is that the higher qualified staff would leave to work in an industrialized country if they do not have expensive modern research tools and the chance to use them for furthering their own specialist interests and publishing papers at international conferences.

The Government itself may encourage this as part of its policy that the laboratory or institute convey an impressive image to foreign visitors.

This results in the familiar situation where approval may be obtained fairly readily for the purchase of an electron microscope or X-ray diffractometer but, through inadequate provision in the budget for maintenance and training, the instrument soon becomes idle. But permission for the local purchase of laboratory cleaning materials may, on the other hand, be obtained with difficulty if at all.

The surest policy for achieving growth in a new institute, and eventually making it a showplace in its own right, is to obtain the interest and support of the industry it serves. The institute should orient itself, certainly for the first few years, to a policy of industrial service, and being able to demonstrate practical examples of the benefits it has gained for its clients in terms of increased efficiency, higher output and better quality products. Then the institute director is in a much stronger position for seeking, and obtaining, from the Ministry as well as from industry itself, the funds needed for extending and improving the performance of the institute.

Some examples of the ways in which this 'service-to-industry' policy can be developed are discussed here together with other points relating to the work of laboratories in development of new industries.

### 3.1. Industrial Experience

Staff should spend some time, especially upon first joining the institute, working at some of the larger factories. This is so that they become familiar with the raw materials and production process and establish

their own contacts with managerial and technical personnel in the industry.

### 3.2. Feed-back from Industry

Industrialists should be encouraged to visit the laboratory and meet the staff. Considerable motivation will be achieved amongst laboratory staff working on routine testing or development work if they can discuss with the visitors, as well as with the institute director, the industrial significance of their work and its results.

### 3.3. Assistance at the Level of Intermediate Technology.

Development work and routine testing should not be restricted to that for large, modern plants, either existing or planned. Much of the national production of clay bricks, tiles and lime, for example, may be coming from the many small traditional kilns employing a large number of people. In conditions of high unemployment, these factories should receive a programme of training and in-the-field technical assistance. The co-operation of local industry ministry personnel will normally be included, both for the planning and follow-up stages.

Illustrated guides to the appropriate methods of manufacture, including standardization of sizes and quality as well as simple quality control tests, should be issued and explained to the factory owners themselves. Two or more levels of technology should be demonstrated, from entirely manual with wood firing through to simple, power-driven mechanical equipment and oil or gas burners.

### 3.4. Appropriate Laboratory Equipment and Test Methods.

In the early stages of the life of the institute, the

the equipment and procedures used for testing should be relatively simple, easy to use, <sup>and</sup> capable of servicing and repair locally. The capital cost should be low, of course, provided the performance and accuracy of results is that required.

Just as industrial operations have to be at the level of appropriate technology, so there is the need to ensure the introduction, from the planning stage of a new laboratory, of appropriate test methods and apparatus. The smooth running of a service laboratory, backed up by an adequate supply of consumable items such as test sieves, spare fuses and standard reference samples, is priority over the purchase of expensive high technology equipment from abroad.

### 3.5. Raw Material Data.

One of the institutions, whether it be the geological survey itself or those serving industrial sectors, such as ceramics, should establish and maintain a national centre for raw material data. Although good work may be done on sample collection, mapping, photographing, testing and reporting in connection with the evaluation of deposits, too often the results later cannot be retrieved for lack of a system of filing samples, photographs and reports, etc. Similarly, reports from one institute may not reach staff in another laboratory who can use that information.

### 3.6. Planning of New Projects

Institutions will be called upon to participate in the planning of modern plants having large production capacities. Great care must be taken in their location

so that there is the least possible risk to the livelihood of the families operating the small traditional factories. Therefore the institute will have to include an accurate market survey to establish that there will be continuing demand for their products as well as those of the new factory.

### 3.7. Reporting.

Reports on raw materials investigations should be written for the benefit of the industrialist or ministerial industrial development official rather than as an academic exercise for the author. The client is entitled to receive a presentation of the results with conclusions based on them. These will show what products can be made successfully with raw materials from the various deposits examined, the reserves available and, hence, the possible scale of production that could be supported and the process data, such as firing temperature, as well as any special treatment or preparation of the raw material.

### 3.8. Co-operation in Survey Work

Raw material inventory surveys are normally the work of the geological survey. However, there should be the collaboration of raw material specialists from the other institutions interested in those materials. Similarly, any detailed one deposit investigation for a new plant by the ceramic specialists, for example, should have the co-operation of the geological survey and be reported to them, within the constraints of confidentiality required by the client. The subject of the co-ordination

of institutional work on raw materials and building material development is discussed in the next chapter.

### 3.9. Use of Consultants

In planning, for example, an overall development strategy for the building materials industry, or a branch of it, it can be advantageous to have the assistance of an outside independent consultant. The selection of this consultant, perhaps through the auspices of a United Nations agency, requires care to be certain that the person selected has wide enough experience in this field and is, preferably, not associated with any supplier of process equipment. Otherwise there is the risk that the recommendations received will not be the most appropriate. In addition to an overall knowledge of building materials manufacture and the construction industry, the adviser has to be able to recognize the industrial significance of various deposits of raw materials. Ideally, there should be experience of production processes at all levels of technology so that the proposals deal both with the requirements for modernization as well as the needs of the small traditional factories. Finally, there should be the ability to assess the present and likely future market conditions and, therefore, predict with realism the demands that are likely to be placed upon the various sectors of the industry in future.

4. INTER-INSTITUTE CO-ORDINATION IN THE DEVELOPMENT OF BUILDING MATERIALS INDUSTRIES : AN EXAMPLE FROM SOUTH-EAST ASIA.

Quite commonly there will exist no single laboratory, institution or ministry, even, that operates entirely within, or itself completely covers, the development of raw material sources for the ceramic, building and related industries. In some of the smaller or newly independent nations, such work may be dealt with within one national institute for technology. As the industrial development of that country progresses and the demands for specialist technical staff and facilities grow, so the original small sections in that institute will develop into divisions responsible, amongst others, for geological surveying, ceramics, other building materials such as cement and concrete, mining, forestry, etc.

Having started off under one roof and remaining together on the same site - assuming there has been proper provision for inevitable growth - the co-ordination of the related activities of each division will be fairly straightforward. Duplication of investigations, which wastes available resources, can be avoided. At the same time, co-operation (with some overlap which can be mutually beneficial if it is recognized and controlled) can be arranged so that information and experience is passed between members of a project team drawn from two or more laboratories.

Unfortunately, such close knit co-ordination of effort tends to be the exception in some of the longer



established developing countries, as it is in some industrialized nations. Contacts at any level may be difficult owing to the geographic distances between the locations of different institutions. Sometimes the attitudes of administrators may inhibit the development of informal contacts at section level which can often be so fruitful. The successful co-ordination of work in a field as diverse as the non-metallic rocks and minerals and their utilization depends most, of course, on the character of the people concerned and especially the degree of dedication and enthusiasm of the various directors.

One country at least, in South-East Asia, has a history of co-operation in certain fields between its specialist institutes in the mining, industry and public works sectors. Lately this has been extended to include work on the location, evaluation and use of all non-metallic raw materials principally, but not exclusively, for the building material and ceramic industries. Some details of the situation are presented here as the actions taken may, with modifications, be applicable through TCDC to dealing with similar development work for establishment of new industries in other countries.

#### 4.1. The Country Situation.

It is a large country, well endowed with mineral resources and undergoing fairly intense industrialization based on export earnings principally from petroleum and metalliferous ores. The situation with industrial

minerals and non-metallic products is that described in the Introduction, i.e. increasing quantities being imported even though the country possesses its own deposits of many of them and and much of the country has yet to be surveyed.

There are few geologists working in the non-metallic field. The courses of the various university geological departments are aimed primarily at supplying graduates for the petroleum and metalliferous mining industries.

#### 4.2. The Institutions

There is a large Geological Survey Institute with a Section for Non-metallics. This and a Mineral Technology Development Centre, which includes mining and beneficiation techniques, comes under the Ministry of Mines. The Ministry of Industry has a Ceramic Research Institute for clay-based building materials, refractories, glass and pottery as well as the raw material and processing investigations on lime and expanded clay lightweight aggregate. The same Ministry has a Materials Testing Institute; amongst the materials examined are aggregates for concrete, etc. and there is training given in concrete technology.

Work on the improvement and development of other building materials is done at the Building Materials Development Laboratory of the Directorate of Building Research and is within the Ministry of

of Public Works and Electric Power. It develops, for example, processes for limemaking and lime-based products, with utilization of natural pozzolanas, and sets up demonstration plants throughout the country. The Laboratory has close links with the Ceramic Research Institute over projects for lime manufacture and production of artificial lightweight aggregate from clay or shale. The Ministry has a separate laboratory for soil mechanics tests.

A fourth Ministry, that for Home Affairs, regulates the small-scale mining operations in the non-metallic mineral sector.

#### 4.3. Co-ordination of Activities

In addition to co-operation in the lime and lightweight aggregate projects, there had been regular contact between the Ceramic Research Institute and the Geological Survey over raw materials investigations and also with the Mineral Technology Development Centre. Recently, contact between all the Institutions mentioned has been greatly strengthened with the setting up of a joint Co-ordinating Organization for the non-metallic raw materials consumed principally by the building and ceramic industries. The scope of the Co-ordinating Organization's work is from exploration, evaluation and processes of primary treatment through to processes for utilization of the materials.

The composition of the Co-ordinating Organization is the Directors and/or appropriate Section

Leaders from each of the Institutions together with certain co-opted members such as from the Ministry of Home Affairs.

One of the first main achievements of the Co-ordinating Organization was to hold a National Workshop Meeting on the subject of The Role of the Non-Metallic Rocks and Minerals in Industrial Development. Besides representatives of the Ministries and Institutions involved, there was attendance and presentation of invited papers from industrialists producing and consuming these materials.

It has been possible from the Meeting to determine the nature of the problems that exist and have a much clearer idea of what steps have to be taken by the Government and the Institutions. The aim is to promote the development of national sources and to see that national industrial consumers, particularly the building material and construction industries, obtain the volume and quality of materials they need, either as specific quality raw material or finished product.

As the composition and activities of the Co-ordinating Organization span across four Ministries, it may take some time for it to reach fully effective operational status. Without knowing what will be agreed eventually, two of its main functions could be :

- Organize co-operation and information exchange on raw materials between the Institutes that work on the ex-

exploration, evaluation and methods of mining, beneficiation and utilization of the non-metallic rocks and minerals.

- Organise an annual meeting between the Institutes and the industrialists. The purpose of the meeting, which would be preceded by several preliminary contacts and discussions, would be, firstly: to review the results of exploration and evaluation work done during the previous year, secondly: receive from the producing and consuming sectors data relating to their problems and technical assistance requirements, and, thirdly: agree the priorities for the field work and evaluation programme for the current year.

##### 5. THE ROLE OF UNIDO

In the example described from South-East Asia, three of the Institutes were already participating in a UNIDO/UNDP project "Assistance to Industrial Development of Building Material Manufacture" One of the project activities was that of Raw Materials Assessment. The UNIDO specialist in this field, through collaboration in field work and laboratory investigations, was able to gain a close insight into the situation relating to the development of national sources of non-metallic raw materials. The need for extending the inter-institution co-operation to include all raw materials in this sector was outlined, as a means of combating the problems existing. Proposals for the content of the technical programme of the National Workshop Meeting were made to the Co-ordinating Organization.

However, the undoubted success of the National Workshop Meeting and the present strength of the co-operation between Institutes has been due more to the excellent work of the national Directors and their senior staff. This is the factor of most relevance to consider if other developing countries are going to successfully adopt such procedure for themselves, possibly through the TCDC programme.

For those countries without established facilities for promoting development in the non-metallic sector, the task of establishing a specialist institution for serving the various industries in this field requires a width of professional experience and knowledge that may not be found within a single person or consulting organization. The previous experience of UNIDO in just this type of project and the many expert specialist consultants available to it, make that Organization one of the most suitable for co-operating with Governments in the development of technical institutions.

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### SUMMARY

Compared with the petroleum and metalliferous mining industries, the exploration, evaluation, production and processes for utilization of the non-metallic rocks and minerals, used mainly by the building materials and construction industries, have been given little priority in most developing countries. As a consequence, increasing quantities of costly refined industrial minerals and materials such as refractories, white cement, etc., are having to be imported from industrialized countries.

Governments of the smaller countries can assist the mining activities in the non-metallic sector, and the local consumer industries, by establishing a national technical centre. This would have geologists and engineers with testing facilities available for evaluating deposits of raw materials and for developing processes such as for ceramic, lime and lime-based industries as well as provide training courses.

In the more prosperous developing nations, various specialist institutions may already exist for geological survey work, mining development and ceramic and other building material investigations. Governments there have to ensure that there is co-operation between the institutions in areas of overlap and elimination of duplication of activities.

At least one country in South-East Asia has co-ordinated work in the field of raw materials, for its building material and ceramic industries, being done by five institutions. Four separate Ministries were represented during meetings of the Co-ordinating Organization. A national Workshop Meeting, with discussion of invited papers from industry and the institutions, has highlighted the problems and provided data for a plan of action to deal with them.

For technical institutes to be successful, they should, from the start, concentrate on providing a service to their respective industry sectors. There are several practices that can be adopted to ensure that the work of the institute is correctly oriented in this direction.

UNIDO has considerable experience in the establishment and strengthening of technical institutions and a large number of specialists it can call upon to provide training and technical services. In addition the costs of the project can be shared and provision made for continuing short-term specialist consultancies as the need arises.





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