Mineral Resource Assessment and Long Term Supply of Minerals

by

MR. D. E. de S. JAYAWARDENA
Deputy Director, Geological Survey Department

Abstract : Mineral Resource Assessment means the estimation of a nation's mineral resources and their classification into appropriate categories. The term resources is used to refer to quantities of foreseeable economic interest that are available for exploitation.

The main objective of embarking on a mineral resource assessment programme is to plan-out the strategy for the long-term supply of minerals for existing mineral based industries taking into consideration the expansion programmes of such industries. In Sri Lanka, the mineral sector industries are broadly categorised into (*a*) industries based on local minerals and (*b*) the exploitation of minerals available locally for the export market.

An attempt has been made in this paper to outline the basic principles of mineral resource assessment based on increasing degree of geological assurance and economic considerations. Such a resource classification scheme called the "Mckelvey Box" as adopted by the U. S. Bureau of Mines and the U. S. Geological Survey is attempted and the adequacy of local mineral resources to sustain mineral based industries is described. Since mineral resources are non-renewable, the optimum utilization of such resources is emphasised keeping in mind the impact of exploitation on the environment.

Introduction

The assessment of a nation's mineral resources is a vital pre-requisite in establishment of mineral based industries on a sound economic footing. In Sri Lanka, mineral based industries particularly ceramics and cement, were established before carrying out a proper assessment of minerals available locally. With the expansion of these industries over the past two decades, the availability of cement and ceramics raw materials which could be exploited economically has to be given serious thought. The steel industry that was established in 1958 was on a phased programme and phases 1 and 2 were planned to utilize imported steel billets and scrap iron. Stage 3 which envisages the utilization of local iron ore is vital for the continuation of this industry, as past experience has shown that the viability of the steel project depends on the price of scrap iron and billets in the world market. At present the high cost of steel products is directly attributed to cost of steel billets and the electricity charges.

The ceramics industry has expanded in a rapid manner with the establishment of production lines for export of porcelainware and wall tiles. Due to the increased building construction activities there is an unprecedented demand for sanitaryware and structural clay products such as tiles and clay pipes. The cement industry too has undergone rapid expansion in keeping with the increased demand for portland cement in the country.

Since the economic viability in sustaining these vital industries depend heavily on local raw materials, the planned exploitation of minerals such as clay, feldspar, ball clay, kaolin, limestone, cement clay etc., has to be initiated. The main drawback in embarking on such a planned exploitation programme is the lack of a proper assessment on the availability of such minerals in Sri Lanka.

Mineral resource assessment has to be carried out on the basis of availability of minerals based on economic feasibility and greater geological assurance. This paper describes as to how such as assessment programme could be initiated giving much emphasis on the long term supply of minerals. In analysing such a resource assessment programme the two major mineral based industries ie: the ceramics and cement have been taken as examples and these guidelines could be expanded to the other sectors as well.

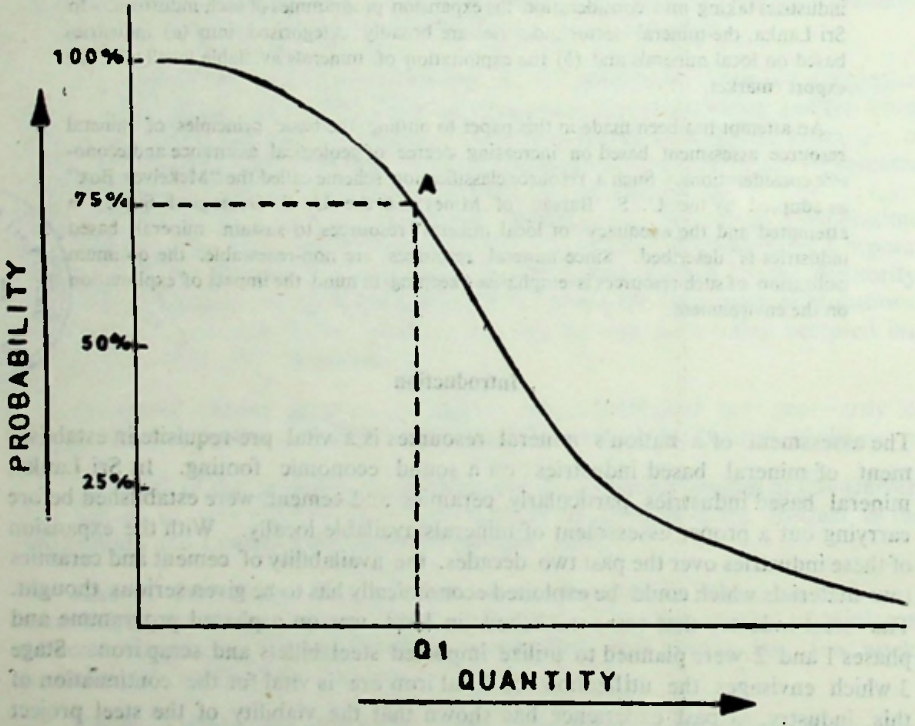


Fig. 1. Resource estimates as a function of uncertainty. The curve shows that in the judgment of the resource estimator chances are 75 percent (three to one) that there is at least Q 1 in a form satisfying the given economic conditions.

(After Jan Zwartendyk 1981)

1. Mineral Resource Assessment

When we think of mineral resource assessment the first question that comes to one's mind is "how much do we have by way of mineral resources"? This question could be answered in different ways such as:

(*a*) How much of minerals we have based on geological assurance (Project Fig. 1). From this curve it is clear that a quantity could be chosen based on geological probability. In this curve much emphasis is laid on geological assurance and economic constraints and assumptions have not been spot-lighted.

(*b*) A more common framework of resource assessment follows the principles of the Mckelvey Box (Project Fig 2) and this framework provides for resource quantities not only in gradations of geological assurance but also in gradations of economic attractiveness.

Therefore the conceptual framework of either Fig 1 and 2 can be a practical way of resource classification.

However these are not the only ways in which a proper resource assessment could be undertaken. The most important factors that a person who embarks on a resource assessment programme should keep in mind are the purpose and objective for which this assessment is required.

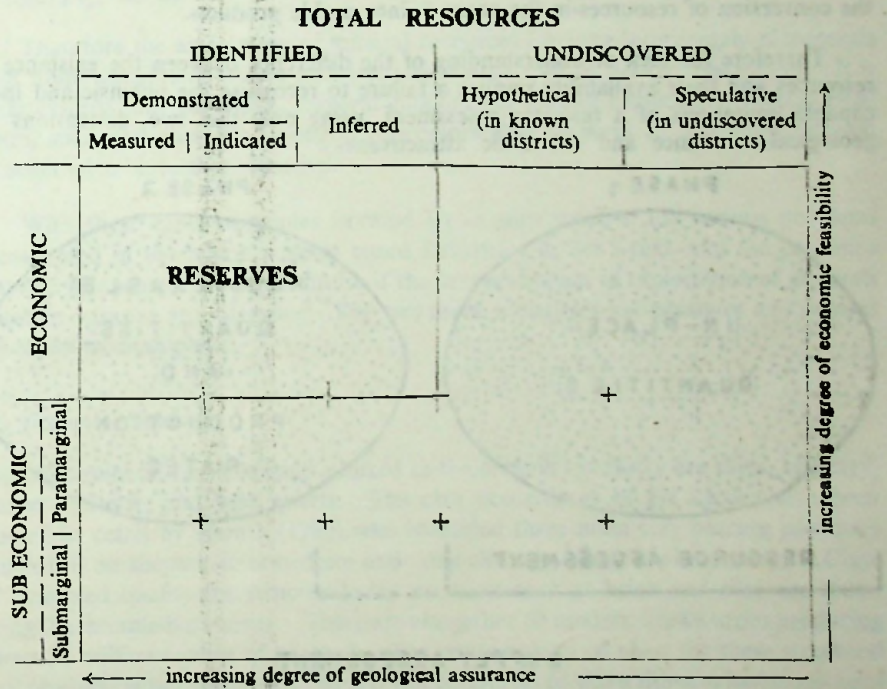


Fig. 2. The McKelvey Box a resource classification scheme of the U. S. Bureau of Mines and the U. S. Geological Survey (from U. S. Geological Survey 1976).

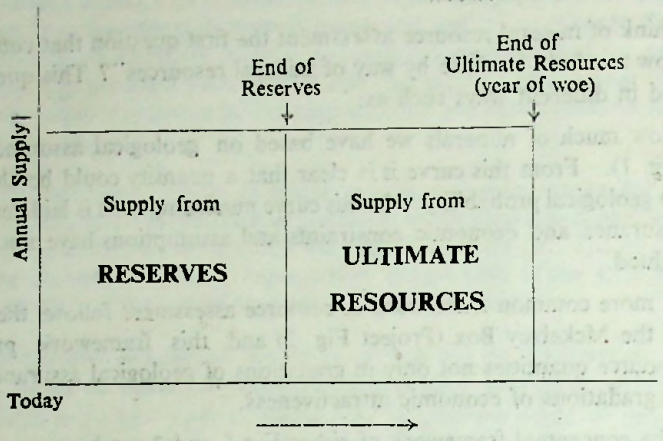


Fig. 3. A common public misconception

(After Jan Zwartendyk 1981)

However it is the experience of resource assessors that it is difficult to avoid misinterpretation of such an assessment due to the layman not taking into consideration of vital factors such as cost and time and the technical problems involved in the conversion of resources-in-the ground into usable products.

Therefore the lack of understanding of the difference between the existance of resources and their availability implies a failure to recognise the intrinsic and inescapable limitations of a resource assessment using only the two dimensions of geological assurance and economic attractiveness.

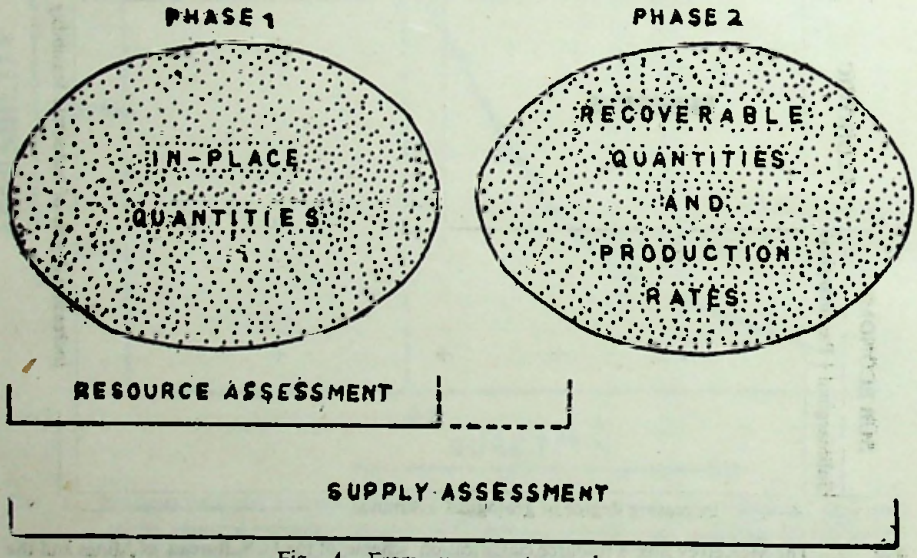


Fig. 4. From resources to supply.

(After Jan Zwartendyk 1981)

Any effective resource assessment programme should take into consideration the following key factors :—

1. Is the mineral in place or recoverable? If recoverable is it in a marketable form?

2. What quantities are associated with existing production facilities and in infrastructure?

3. What quantities are producible, and at what rate, in the next few years? in the next decades?

4. To what extent would production of one commodity lead to co-production of other commodities?

Therefore with the ultimate objective of the availability of minerals on a long term basis, we identify that resource assessment under phase I as broad supply assessment and this phase is mainly concerned with the assessment of *in-place quantities.*

Phase 2 is mainly concerned with an assessment of *recoverable quantities and production rates.*
(Project Fig. No. 5).

Therefore the assessment of mineral resources for long term supply of minerals is of multidisciplinary nature and needs the interaction of various disciplines. It is quite evident that geologists, mineral economists, mining engineers, chemical engineers, analytical chemists, mineral processors have to work in close collaboration in order to achieve this objective.

With these basic principles in mind let us now analyse the various problems encountered in the major mineral based industries in Sri Lanka and the problems that will be encountered in the future if the present system of exploitation of minerals continue without any planning. The two main industries i.e. ceramics and cement are taken as examples.

The Ceramics Industry

The basic mineral raw materials utilized in the ceramics industry are clays, ball clay, kaolin, feldspar, and vein quartz. The clay occurrences of Sri Lanka have been studied in detail by Herath (1980) who identified three main clay bearing provinces which fall on the wet intermediate and dry climatic zones of the country. Clays of accepted quality for structural clay products such as brick and tiles are found along the intermediate zone. There are altogether 50 modern tile factories producing about 35 million tonnes of product. The consumption of clays for these structural clay products is not quantified and it is not certain as to when those valuable resource will be exhausted. Apart from these 50 major tile factories, much clay resources are utilized for small scale tile factories.

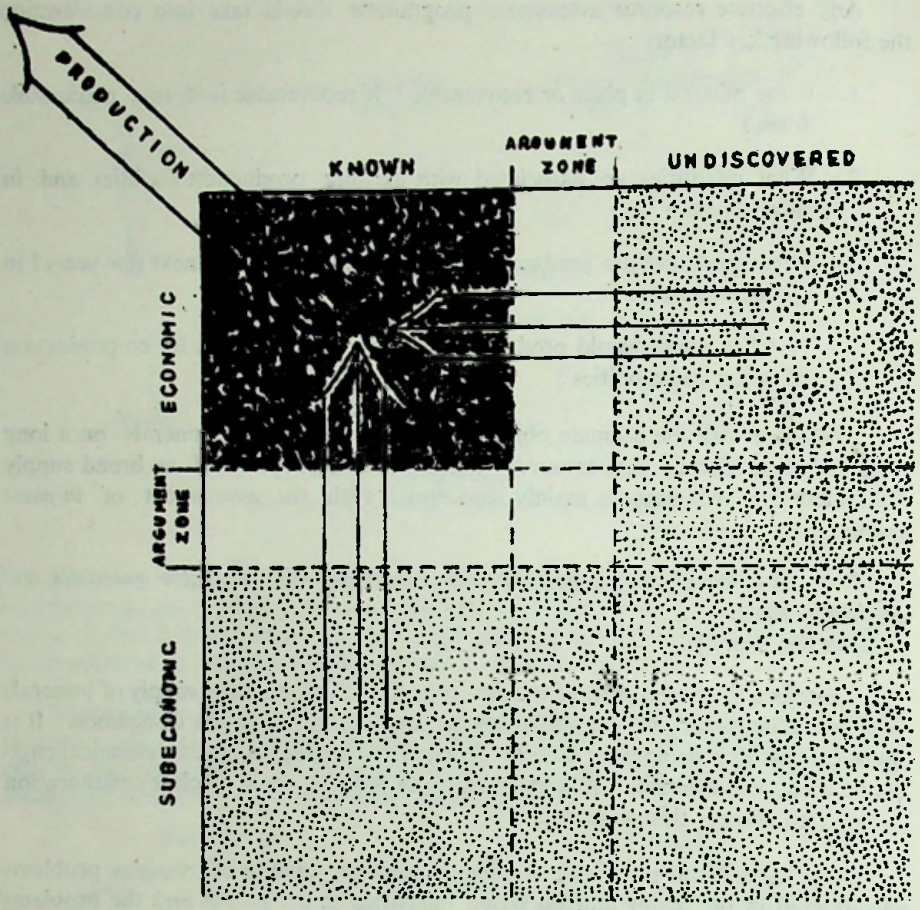


Fig. 5. The essentials of a resource assessment.

(After Jan Zwartendyk 1981)

If a resources assessment based on the Mackelvey Box has to be attempted first, we have to ascertain the quantities available on geological assurances. Then the resources have to identified as economic or sub-economic etc.

Regarding the other ceramic raw materials we have no knowledge of the quantities available and exploitation is carried out of deposits located by the Geological Survey. There is no proper evaluation of feldspar and the rates of consumption annually has to be first ascertained to assess this resource on the principles laid down by the Mackelvey Box.

As far as ball clay and kaolin are concerned the resource evaluation has to be carried out very carefully as utilization of these resources will depend heavily on the assessment of quality as well as quantities available.

It is quite evident that there is no detailed resource assessment directed at long a supply of minerals presently utilized in the ceramic industry. Therefore, personnel engaged in planning of mineral extraction in industry are unable to state the availability of such resources to sustain the ceramic industry in the future at the present level of consumption. If timely action is not taken to embark on such a mineral resource assessment programme for the ceramic industry. a time will come when this industy will have to import raw materials thus making it financially not attractive due to increased production costs.

The Cement Industry

The cement industry is presently expanding with additional capacities at KKS. At present nearly 2 million tons of miocene limestone are utilized for manufacture of cement both at KKS and Puttalam. The availability of clay does not pose a problem except at KKS where the clay resources are hauled from Mannar. The earlier concept was that there are unlimited reserves of miocene limestones along the north-west coastal belt stretching from Puttalam to Mannar, then to Jaffna Peninsula and Mulaitivu along the north-eastern coastal belt.

However the Geological Survey has noted that exploitable reserves are available only at Aruwakalu, Parippukandanthan near Mannar and at KKS.

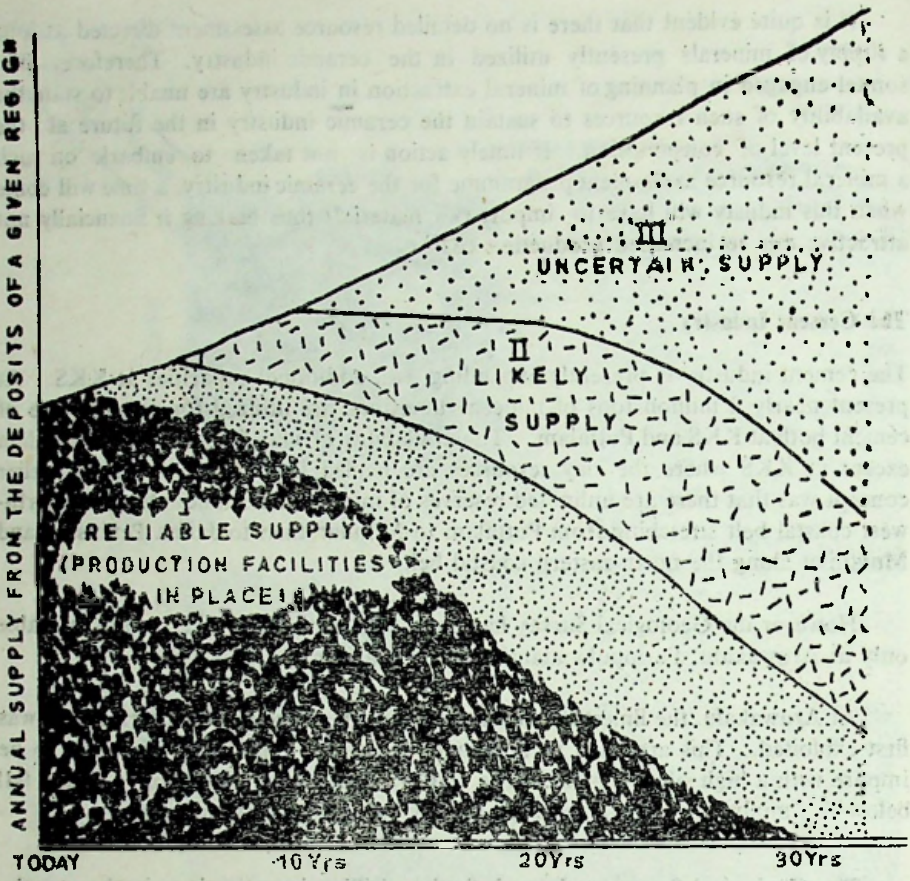
At Aruwakalu, the limestone occurs in a hill where the north-eastern sector was first exploited. This area had to be abandoned as the limestone was found to be impure with a high silica content. The $CaCO_3$ content was less than 76% and fell below this minimum which is required for dry process cement manufacture.

The Geological Survey undertook further drilling investigations in the south-western part of Aruwakalu to ascertain whether limestone of acceptable quality is present. These investigations have proved about 30 million tons overlain with an overburden of red earth. The thickness of the overburden varies from 15 to 75 feet and the economic viability of extraction of this limestone will depend on the over burden thicknesses.

The exploitation of miocene limestone at Parippukandanthan will depend on the initial capital investment required for the infra-structure. The transport of this limestone to Puttalam will be the major economic constraint.

The exploitation of limestone in KKS is controlled by the low water table as the deposits are in close proximity to the sea coast. The availability of bare land for exploitation is also a major constraint.

A careful analysis of these factors reveal that the expansion of the cement industry should be planned with the availability of the limestone resources that could be exploited economically.



RELIABLE SUPPLY:

From deposits now being mined
(First from today's measured and indicated reserves, then from extensions now inferred)

LIKELY SUPPLY:

From known, promising, but as yet undeveloped deposits (First from todays measured and indicated tonnages, then grom extensions now inferred)

UNCERTAIN SUPPLY:

(i) From uncertain extensions (beyond inferred) of I and II.

(ii) From deposits still undiscovered and/beyond foreseeable economic reach

Fig. 6. Supply of a mineral commodity (mine production from a given region to meet given requirements)

(After Jan Zwartendyk 1981)

Conclusions

An attempt has been made to spotlight the need to carry out mineral resource assessment with the main objective of long term supply of minerals to sustain and expand the already established mineral based industries.

At present the exploitation of clays, feldspar, quartz, ball clay, kaolin, limestone and cement clay is carried out by the Ceramics and Cement Corporations without any idea of the availability of these valuable minerals for long term supply to sustain these industries. Wastage due to the adoption of unsystematic mining methods will also contribute to a great extent to the depletion of these resources at a rapid rate. At present both the Ceramics and Cement Corporations do not have experienced mining engineers to plan out systematic exploitation of these raw materials. In order to rectify this situation, it is suggested that these state sector organisations should immediately initiate a long term plan to assess the availability of raw materials. In order to draw up such a long term plan, these organisations should recruit mining engineers and economic geologists.

The impact of mining operations on the environment is a vital factor which has been neglected over the years. The state sector as well as the private sector should carry out exploitation of minerals in a planned and systematic manner without disturbing the natural environment and strict controls of such activities will prevent major health hazards due to environmental pollution.

The Geological Survey Department is charged with the responsibility of mineral resource assessment in relation to long term supply of minerals for industry, and control of mining activities under the Mines and Minerals Law No. 4 of 1973. At present the Geological Survey is unable to effectively carry out its legitimate functions due to lack of trained staff and equipment. A proposal to upgrade the institutional facilities of the Survey with the assistance from the Asian Development Bank was presented to the Govt. in 1980 and could not be implemented due to the Treasury refusing to provide local counterpart funds. Due to short sighted policies of the Treasury, a detailed resource assessment in the mineral sector field cannot be embarked on as the Geological Survey is not geared at present to undertake this task. This delay will have serious repercussions on the mineral sector industries of Sri Lanka and time will come a when our resources will be depleted due to the unsystematic exploitations and mining operations that are presently adopted.

References :

1. HERATH M. M. J. W. (1980) — Mineral Resources of Sri Lanka Econ, Bult. No. 2 (Revised) Geological Survey Department, Sri Lanka.

2. JAN ZWARTENDYK (1981) — Economic Issues in Mineral Resource Adequacy and in the Long-Term Supply of Minerals. Econ. Geol. Vol. 76, No. 5. pps. 999 - 1005.

3. U. S. Geological Survey (1976) — Principles of the Mineral Resource Classification System of the U. S. Bureau of Mines and U. S. Geological Survey. U. S. Geological Survey Bult. 1540-A 5 p.