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~~REPORT~~ PROPOSAL FOR A MULTIANNUAL R & D PROGRAMME
IN THE FIELD OF PRIMARY RAW MATERIALS
(indirect action)
(1978-81)

(submitted to the Council by the Commission)

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Proposal for a multiannual R & D programme
in the field of primary raw materials
(1978-81)

SUMMARY

This proposal deals with primary raw materials. It is aimed at alleviating in the mid to long term the problems of supply of the Community in basic raw materials by

- a) increasing the self-supply potential of the EC
- b) developing new techniques for use by the EC mining industry within and without the territory of the Community.

The four-year programme (1978-81) includes the following three research areas :

- 1) Exploration. Emphasis is laid on the detection of concealed and deep-seated deposits. Two main topics for actions are included :
 - refinement of the criteria leading to target selection, through detailed studies in applied geology
 - improvement of prospecting methods and techniques; with regard to geochemistry and geophysics, traditionally-used methods will be perfected and new approaches will be defined; the potential of remote sensing, from aircraft and satellite, a fast developing field, will be assessed. Work on drilling techniques is also recommended.
- 2) Processing of low grade ores and of complex ores. Actions are proposed on copper, lead and zinc ores, as well as on sources of alumina other than bauxite. Significant resources of this type are scattered throughout EC countries.
- 3) Mining technology. Deep mines and high grade-low tonnage deposits are considered as priority fields for R & D.

Environmental protection concerns will be given due consideration in planning the R & D projects to undertake.

The contribution from the EC budget to funding this programme is estimated at 23 M.u.a. for 4 years.

The programme will be managed by the Commission in close association with an Advisory Committee for Programme Management. Flexibility and decentralization in the management of the R & D programme will be furthered as much as possible.

The programme will be implemented by means of indirect action (cost-sharing research contracts). Relevant R & D projects will be carried out by national research organisations and public and private industry.

Proposals for carrying out concerted actions on specific topics connected to the present indirect action programme will be submitted separately in the near future.

The programme will be reviewed periodically to take into account the evolution of R & D requirements.

INTRODUCTION

The Community depends to a large extent (70 to 100%) on external sources to provide its needs in raw materials of most kinds. Although the degree of dependence varies considerably from commodity to commodity, in general, sources of supply are not sufficiently diversified and guaranteed procurement is not assured.

In recent years serious concern has arisen, prompted by the energy "crisis" of 1973-74, with regard to the prospects of supplying the needs in raw materials of our economy in sufficient quantities and at acceptable costs, in a mid-or long term perspective.

Consequently, in each Member State, measures have been taken or planned, calling for increased intervention of public authorities in order to ensure and guarantee adequate supplies.

In the long run, however, hopes for a satisfactory solution should reside in a Community-wide supply policy which will take into account the converging interests of all Member States through actions at the economic and political levels, to be carried out both within the EC and in its relations with the outside world. In a first communication to the Council (Com 50 (75)) the Commission has proposed various orientations aimed at developing such a policy. Among the problems mentioned are : the security of long-term supplies, guarantees for mining investments abroad, price stabilization, increases in internal resources and economies in the use of raw materials.

In line with the above initiative, CREST and the Commission departments undertook in December 1974 to collect information at national level on ways and means by which R & D could contribute to alleviate the supply problems of the Member States. A subcommittee of CREST was established with the tasks of gaining an overall view of the primary and secondary raw materials sectors and of determining the needs, if any, for joint R & D actions in this field. The subcommittee produced a report (CREST/70/75) in which national contribution on R & D activities in the field of primary and secondary raw materials for each member state were presented and analyzed.

It was found i.a. that everywhere three basic problems were recognized with regard to the supply of raw materials :

- 1) an incomplete or unsatisfactory knowledge of the current status and prospects for each raw material commodity,
- 2) the prospects of absolute or relative shortage in the medium to long term for several commodities,
- 3) the need to improve possibilities of self-supply.

The Sub-Committee recommended to initiate technico-economic studies ("dossiers") for several raw materials commodities (copper, lead, zinc, aluminium and phosphates) as well as other studies in the area of recycling and recovery of materials. It also identified 12 topics for R & D in primary raw materials which it considered could be developed into a programme proposal before the final results of the dossiers were available.

In February 1976 CREST endorsed the report of its Sub-Committee and recommended that together with the Commission department it prepare Community R & D actions along the lines it advocated and submit them to CREST as soon as they were ready.

The present proposal concerns the first such R & D action.

It deals with primary raw materials (excluding natural uranium) and includes topics for R & D which are grouped in the following research areas : 1) exploration, 2) ore processing and 3) mining technology. It emphasizes work aimed at increasing self-supply possibilities in the EC, mostly for non-ferrous metals, while not neglecting the prospects of using abroad, or exporting, new techniques of prospection and new technologies for low-grade ore processing. In presenting this programme the Commission is aware that its objectives will be reached only if a very close cooperation is established between industry, research organizations, national authorities and the Commission, on behalf of the Community, at every stage of the execution of the R & D programme.

A Community action programme of R & D in primary raw materials is justified on several grounds :

- There are unknown and/or untapped mineral resources in the geological substrate of the territory of the EC, according to the experts. These resources are present in the form of either deep-seated or concealed deposits, low-grade and/or complex ores, or high-grade low-tonnage deposits. A joint effort is needed, at Community level, to make their detection or exploitation possible. Such an initiative is necessary, in the present economic context, to stimulate mining interests, whether publicly or privately owned, to augment the possibilities of self-supply of the EC in several potentially critical commodities, identified by preparatory work in the Commission on the definition of a Community raw material supply policy. It should be noted at this point that all over the world initiatives are taken by industry to exploit low-grade ores in view of the increasing scarcity of rich deposits.

- A country's potential in mineral resources is obviously determined by its geology : indeed a large variety of geological conditions may be found between Sicily and Scotland, or between Ireland and the eastern reaches of the Federal Republic of Germany. This, to a certain extent, results in a measure of complementarity of the mineral resources of the member states, however limited these might be. On the other hand, some basic geological structures are common to two or more countries. Thus, studies aimed at uncovering hitherto unknown deposits (especially of the deep-seated or concealed varieties) must consider promising geological formations throughout their extent, across national boundaries, and bring into play the whole arsenal of more or less sophisticated prospecting techniques that are mastered collectively by the experts of all member states.
- In the area of extraction and processing of ores, particularly of the low-grade and complex types, preliminary studies are undertaken at first but, if successful, must be followed by pilot operations, provided these are justified economically, e.g. by the extent or number of the deposits. These operations are often expensive, hence the desirability of spreading not only the costs, but also the know-how to be gained, by having them carried out by multinational Community teams in one or a very few suitable locations.
- Such a joint programme will avoid useless duplication of national R and D efforts, enable important new projects to be undertaken and increase the overall productivity of research in the field.
- Even though the issue of a Community policy on raw materials supply is still under consideration, there is a commonality of interests among the member states; increasing self-supply in raw materials for the Community as a whole, is in the common good and should help reduce balance of payment deficits; similarly, using or exporting newly developed technologies for exploration and exploitation of mineral deposits should help ensuring continued supplies from developed and developing third states.

The present programme proposal is aimed at research objectives which should yield practical results in the medium term (especially in the areas of extraction, ore-processing and mining technology where the sites have already been identified) and the mid-to long term (e.g. the applied geology studies and the improvement of prospection methods).

Care was exercised to select research topics which would 1) complement or reinforce current national R & D programmes, 2) be consistent with the needs of industry in the member-states, 3) involve, as much as possible, research groups from several countries which will cooperate in joint projects to be carried out in a single location, or complement each other in working out new techniques, or in applied geology studies.

PROGRAMME OUTLINE

The research areas and topics are described in detail in the following pages. In summary they include the following :

Research area I : Exploration

- I.A. Concealed and deep-seated deposits in the E.C.
- target selection by improvement of knowledge in applied earth sciences.
- I.B. Improvement and development of prospection methods and techniques :
- geochemical
 - geophysical
 - remote sensing
 - drilling

Research area II : Ore-processing

- II-A. Feasibility and model studies
- II-B. Specific ore processing and metal recovery actions (in situ leaching, alternative sources of alumina, lead-zinc complex ores, chlorination and other processes, etc.).

Research area III : Mining technology : for deep deposits and high grade-low tonnage deposits.
Environmental concerns are taken into consideration, whenever appropriate, especially in research areas II and III.

The draft programme is concerned with research areas and topics of interest. These are not listed in any order of priority. The programme takes into account national experiences and contributions presented by **experts from the Member States**

Specific research proposals from bodies in the member states will be considered if they pertain to the topics included in the programme. Use will also be made of the recommendations from the "dossiers" on various commodities which will be available in time for the examination of the proposals.

As much flexibility as is compatible with sound management of such a coordinated programme will be preserved to avoid stifling original ideas and to increase overall efficiency.

WAYS AND MEANS

The EC contribution for the above programme proposal is evaluated at 23 Mua for 4 years. Indicative breakdown of funding per research area and topic, expressed as a percentage of total, is as follows :

		%
Research area One	: Exploration	
I.A	Concealed and deep seated deposits	5- 8
I.B1	Geochemistry	7- 9
I.B2 + I.B3	Geophysics + Remote sensing	20
I.B4	Drilling techniques	3- 4
Research area Two	: Ore-processing	
II.A	Feasibility studies, models	3- 5
II.B1	In situ leaching	8-10
II.B2	Alumina from non-conventional sources	21-24
II.B3	Lead-zinc complex ores	4- 6
II.B4	Chlorination and other processes	10-13
Research area Three	: Mining technology	<u>10</u>
		100

Final distribution of funds per research area and topic would be left to the bodies involved in the management of the programme (see below). EC funding would be used 1) to finance cost-sharing research contracts (maximum average contribution of 50%) with research organizations, industry and universities in the member states.

2) to manage the R & D programme (meetings of management committee), organization of scientific meetings, personnel, etc.) which would require about 12.5% of total EC funding.

It should be noted that subjects for possible concerted actions have already been identified under several headings of the programme, namely :

- I -B.1.7 geochemical mapping (page 16)
- I -B.3 remote sensing (page 18)
- II.A. feasibility studies and models (page 20)
- III.B. high grade-low tonnage deposits (page 26) , for the part : definition and inventory of such deposits).

Proposals for these concerted actions will be prepared on the basis of information on relevant national activities.

IMPLEMENTATION AND MANAGEMENT

The R & D programme will be managed in a flexible and decentralized manner. While the Commission will be responsible for the execution of the programme, it will do so in close working relationship with the Advisory Committee on Programme Management (ACPM) to be established for this programme, with the draft terms of reference.

More specifically the Advisory Committee will advise the Commission with regard to :

- the allocation of available funds among the research areas and topics of the programme, taking into account relative priorities
- the examination and selection for inclusion in the programme of research proposals received from applicants in the member states on the basis of criteria of : relevance and in particular the potential for use by industry, scientific quality, prospects of success, and costs
- the establishment of special working parties and the appointment of project officers for the close supervision of specific parts of the programme
- the monitoring of the progress of on-going research and the formulation of recommendations, if need be, for further work
- the evolution of research requirements throughout the Community.
- periodic reviews and, if advisable, the preparation of revisions of the programme during its course
- the initiation of a progressive coordination of national and Community R & D activities in the field of primary raw materials.

Day-to-day management and coordination will be carried out by the programme officer and the project officers. The latter could be either Commission officials or national experts working under contract on a part-time or full-time basis.

A draft scheme for the management of the programme is given in annex I.

DISSEMINATION OF INFORMATION

The dissemination of information resulting from the programme will be ruled by Regulation (CEE) n° 2380/74 of the Council, dated 17 September 1974.

DETAILED PROGRAMME CONTENTS

RESEARCH AREA ONE : EXPLORATION

There is general agreement among geologists and mining engineers that a number of ore deposits, either just concealed by superficial cover or buried at various depths in the Earth's crust, can still be found in EC countries, provided existing methods of detection are improved and new ones are developed due regard being taken to the need to reduce costs of, and time involved in, the discovery of new deposits. Three types of deposits have been selected hereafter in the proposed programme :

- metal deposits in a volcanic or volcano-sedimentary setting (i.e. "volcanogenic" deposits)
- strata-bound (or stratiform) deposits of lead-zinc and other materials in a sedimentary environment
- metal deposits associated with intrusive igneous rocks.

The content of the programme has been arranged under the following headings :

I-A - CONCEALED AND DEEP-SEATED DEPOSITS

- I-A-1. Improvement of knowledge concerning the types of deposits, their environment of deposition and their genesis
- I-A-2. Improvement of knowledge concerning ore and wall-rock-mineralogy, petrology and chemistry

I-B - IMPROVEMENT AND DEVELOPMENT OF PROSPECTION METHODS AND TECHNIQUES

- I-B-1. Geochemical methods
- I-B-2. Geophysical methods
- I-B-3. Remote sensing
- I-B-4. Drilling techniques

It should be realized that such a classification is somewhat arbitrary, since for instance geochemistry, the subject of heading I-B-1., is one of the tools of research outlined under heading I-A -. Furthermore, work involving each of the types of deposits outlined above arises under any of the broad programme headings I-A-1. to I-B-4. Details of the following programme should therefore be taken as possible examples; further specific programme subareas may be incorporated as the programme develops.

I-A. CONCEALED AND DEEP-SEATED DEPOSITS

Present day mineral prospecting relies heavily on surface or airborne geophysical and geochemical methods. These are chiefly applicable to shallow deposits.

Yet future prospecting research activities will obviously be directed towards deeper and deeper deposits, with increasing difficulties on the part of surface geophysics and geochemistry.

Target selection will be facilitated to a large extent by

- 1) refined knowledge of types of deposits, environment of deposition and genetic aspects
- 2) data obtained from drill-hole samples

On the first of these points, research should be aimed at identifying potentially promising areas in the member states and, within those areas, at selecting the zones of highest probability for discovery. To this end the impressive body of basic data that has been collected by European geologists during the past two centuries will be reviewed, completed and interpreted for the benefit of mineral prospecting.

Referring to the second point, it should be kept in mind that considerable amounts of money are spent each year on drilling and that the samples obtained in this way are often submitted to only very limited examination. Yet many techniques, based on mineralogy, petrology and geochemistry, are now available. They should be tested on the borehole samples and eventually perfected to ascertain in each case if the drill hole has been near a mineral deposit. Given the high technological level of European laboratories, it is believed that important progress can still be made on the subject.

In conclusion, improvement of geophysical and geochemical techniques is a necessity; but this effort should proceed together with the refinement of methods of target selection, knowing that deep-seated deposits will only be found in carefully pre-selected areas. Geology is an essential tool for such an investigation; mineralogy, petrology and geochemistry will also provide useful clues.

I-A-1. IMPROVEMENT OF KNOWLEDGE CONCERNING THE TYPES OF DEPOSITS, THEIR ENVIRONMENT OF DEPOSITION AND THEIR GENESIS

A-1.1. Volcanogenic deposits

This proposed topic for research will comprise inventories of existing knowledge, and detailed studies in various aspects of the earth sciences.

1) Inventories are needed :

- to collect in the member states all available information on the areas underlain by volcano-sedimentary rocks of Palaeozoic age, and to identify potentially promising districts;
- to list the relevant research projects under way in the member states.

- 2) Detailed studies, undertaken at selected locations, will help to define guidelines for future prospecting in a more adequate manner than can be done at present. Among the many possible topics for research, the following are believed to deserve special consideration : regional setting of deposits; extension and chemistry of the volcanic episodes which are responsible for mineralization; ore-body formation as related to the evolution of a volcanic centre and of the surrounding area; ore-body formation as controlled by sedimentology, by palaeogeography and by structural features; geostatistical evaluation of mineral potential.

A-1.2. Strata-bound deposits in a sedimentary environment

Adequate knowledge of the controlling factors of deposit location can again lead to significant savings in exploration. The topics to be investigated in priority are : regional setting of deposits, structural geology, sedimentology and palaeogeography.

A-1.3. Deposits associated with intrusive igneous rocks

The following types of deposits have been selected in the first instance :

- 1) Skarn-type deposits (1): in skarn-type deposits of tungsten and other non ferrous metals, the relationship of metallogenic differentiation to the nature of replaced rock will be studied in detail; also the geochemical spectrum of the country-rocks. As a result of this work, one or more promising area(s) should be selected for prospection.
- 2) Deposits associated with basic and ultrabasic rocks : metal sulphides and oxides frequently occur as disseminations and in massive form within basic and ultrabasic rocks, of which a number of examples are known within the boundaries of the Community. Genetic concepts have to be found to improve methods of detection of these deposits .

(1) A skarn is a special type of rock that was formed at the interface of an intrusive igneous body (often a granite) and of the surrounding country-rock, under the influence of hot fluids released by the cooling igneous mass. In the process of skarn formation, country-rock may be partially replaced by new minerals.

I-A-2. IMPROVEMENT OF KNOWLEDGE CONCERNING ORE AND WALL-ROCK MINERALOGY, PETROLOGY AND CHEMISTRY

Among the many subjects which deserve further study in this context, the following might be mentioned in view of their importance :

A-2.1. Wall-rock alteration

It is hoped that models can be produced for the widespread phenomenon of wall-rock alteration by mineralizing fluids, and used as exploration guides. Types of alteration to be investigated are : dolomitization and silicification of carbonates, alterations in a volcanic setting ...

A-2.2. Ore and wall-rock mineralogy

Several avenues of research are suggested, for instance : isotope studies, thermoluminescence and the study of fluid inclusions. Again, the results obtained can be expected to help orienting prospecting work.

I-B. IMPROVEMENT AND DEVELOPMENT OF PROSPECTION METHODS AND TECHNIQUES

I-B-1. GEOCHEMICAL METHODS

Present-day operational methods of geochemical prospecting are well adapted to prospection for concealed sub-surface deposits, and need only some optimization. On the other hand, prospection for deeper targets in beyond their possibilities and requires new approaches.

B-1.1. Optimization of existing techniques

It is proposed, among other possible actions, to improve our knowledge of the various components - such as iron hydroxides - which serve as "carriers" of the prospected metals during the weathering of a deposit. If a way could be found of concentrating these components at the analysis stage, it should then be possible to increase geochemical contrast with "background values" and consequently reduce the number of samples needed for prospecting.

It is also proposed that methods of improvement in down-the-hole geochemical borehole logging techniques be pursued under this heading.

B-1.2. Whole-rock geochemistry

- 1) Finding "fingerprints" for specific mineralisations
Establishing the existence of gradients of trace metal
contents in rocks should give useful indications for
locating concealed ore bodies. This approach will be
applied in various geological settings : limestones,
shales, volcano-sedimentary rock sequences ...
- 2) Definition of target areas by establishing trace element
patterns in stratigraphic sequences
It is proposed that whole-rock geochemistry be applied to
some specific rock sequences of volcano-sedimentary origin,
in which sulphides are known to occur locally.

B-1.3. Hydrogeochemistry

The hydrogeochemical results obtained on spring or subsurface water are difficult to interpret in terms of prospecting for anomalies linked to metal concentrations. Priority should be given to research on the use of trace elements in water, for which little data is now available.

B-1.4. Gas geochemistry

Highly volatile chemical compounds can be used as pathfinders in geochemical prospecting to obtain information on the composition of rocks and ores at great depth. The detection of such gases as SO₂, CO, H₂, H₂S, CS₂ is still at the experimental stage and shall be investigated.

B-1.5. Geochemistry of tin and tungsten

Actions are needed in the purely analytical field and also towards improving prospecting methods for these metals which are in poor supply in the Community. It is therefore suggested, for example :

- 1) to develop methods for determining and evaluating tin,
tungsten and related elements such as niobium and tantalum.
A good understanding of the manner in which trace elements are distributed throughout bodies of igneous rocks (such as granites) is essential to orient prospection work. At present, analytical methods are not refined enough for use in prospecting and will have to be perfected.
- 2) to study in pan concentrates the "printing effect" of tin
and tungsten on some minerals
It is hoped that all types of tin and tungsten deposits will be detected in this way throughout large areas.

B-1.6. Geochemical prospecting in areas of deep overburden

Geochemical (and geophysical) prospecting presents special difficulties in those areas of Northern Europe which are covered by a thick mantle of glacial deposits or peat. A solution to this problem would be desirable. This topic could be linked to topic I-B-4 on drilling techniques.

B-1.7. Geochemical mapping (in part as concerted action)

Interpretation of geochemical maps for mineral prospecting is hampered by several difficulties: nature and evolution state of soil samples, screening effect of barren overburden, paucity of high-grade information on the physico-chemical state in which trace-elements are transported and held both in stream alluvium and in soils. If these difficulties were overcome, features which may lead to the discovery of mineral deposits would be easier to identify on maps. It is therefore recommended to study:

- 1) transportation of elements in stream sediments
- 2) dispersion of elements in soil and glacial materials, and the resulting geochemical relationships with bed-rock.

It is also suggested that a case study be undertaken in East Greenland, because of exceptionally good rock exposure. Information collected there on the problems of geochemical mapping will allow to set up a model for simulation runs, using screening effects taken from typical European areas.

Finally, it would be worthwhile promoting international cooperation in geochemical mapping. Progress on presentation of maps and on computer enhancement of data necessitates frequent consultation between experts from the member states, under the auspices of Community authorities.

I-B-2. GEOPHYSICAL METHODS

Two types of geophysical approach are used in mining research:

- the direct approach, by which a deposit is sought using its specific physical parameters (electrical conductivity, magnetic susceptibility, density, etc...)
- the indirect approach, by which geological environments likely to favour the presence of mineralised deposits are sought.

Due to the short range of geophysical methods, only very large deposits showing strong contrasts of physical properties can be directly detected at great depths. In contrast, the structures likely to contain deposits, which are generally of greater dimensions than these deposits, can be recognized at somewhat greater depths. As a rule, this kind of research requires the simultaneous use of several geophysical methods in order to reduce the number of possible interpretations which can be made from the data of a single method.

B-2.1. Traditionally-used surface methods

In the short term, it is proposed to improve some equipments and techniques, so as to increase the capacities, depth penetration and effectiveness of the various methods. European experts should meet as soon as possible to exchange information on the methods used in the member states. Tentatively, the topics for future research are listed hereafter.

- 1) Gravimetric methods are best suited to the identification of large structures at depth. Improvements are needed on raw data processing, map transforming, interpretation.
- 2) Magnetism nearly always yields useful information at a low cost. In particular, magnetic anomaly maps can serve to locate deep fundamental tectonic trends, probably the main channels for mineralizing solutions. Progress is needed in the direct measurement of the vertical gradient of the magnetic field.
- 3) Resistivity distribution at depth can provide clues to the existence of conductive ores, and to some structural features. Research is suggested on instrumentation, electrode arrangements and interpretation, to increase depth penetration of the method.
- 4) Induced polarisation is a much used method, still open to improvements. In addition to specific projects, it is suggested that the influence of rock textures be studied.
- 5) Electromagnetism can be used on deep targets, provided the primary signal has a low enough frequency. Available equipment should be modernized.
- 6) Seismic methods are useful for the detection of various structures such as faults. Widely used in oil exploration, they need to be adapted to mining research (use of high frequency seismic waves).

B-2.2. Geophysics in boreholes

The use of probes and sensors in boreholes greatly extends the range of possible investigation. Research is needed on the following subjects :

- 1) acoustic probes, focused resistivity probes, geophysical borehole logging and electromagnetic probes, to obtain in situ physical properties
- 2) neutronic activation, to estimate volumes and grades in situ
- 3) temperature and conductivity surveys

B-2.3. Airborne geophysical surveying

This is a useful tool in locating major faults and possible associated ore-bodies. Ireland, for example, is a recognized copper-lead-zinc province, known to possess deep-seated faults which at least locally are associated with mineralization. The application of such airborne methods might prove fruitful in locating further major deposits.

I-B.3. REMOTE SENSING FROM AIRCRAFT AND SATELLITE (1)

(in part as concerted action)

There exists a need for a definitive assessment of the potential of remote sensing techniques to prospecting for metalliferous mineral deposits. It would seem advisable to set up a joint project in which experience and results from areas of widely differing geology and climate are combined in an effort to create a model for the use of remote sensing in mineral deposit prospecting. Studies will therefore be made in different parts of Europe and in selected areas elsewhere. Among the latter, East Greenland stands out as an ideal test area, because of a happy combination of unusually good rock exposure and well-known geology.

B-3.1. Fracture trace analysis

By processing data from fracture patterns on both satellite imagery and air photography, it should be possible to identify those fractures which affect underlying basement rocks at a depth of a thousand metres or more and which, therefore, represent prospecting targets.

This research needs to be developed.

(1) Airborne geophysical methods are dealt with under B-2.3.

B-3.2. Improved discrimination of lithology in mineralized areas

R & D is needed on :

- 1) understanding of spectral responses of rocks and minerals
- 2) computer enhancement of evidence for mineralization on imagery
- 3) interpretation of areas with thick soil and vegetation cover.

In humid regions, indications on the bedrock can only be gleaned indirectly from the properties of vegetation. This is a field for proposed R & D, which could proceed along two lines :

- a) evaluation of the literature concerning the phenology of the Earth's vegetation cover and its ecological condition
- b) physiologic anomalies and spectral response of plants

I-B-4. DRILLING TECHNIQUES

Drilling techniques should be improved and developed in order to extend their use in prospecting and reduce their cost. For example :

- a) by freezing the geological formation just ahead of the drill-bit, it is expected to improve drilling speed, reduce costs, and prevent soft terrain from sloughing in.
- b) for areas of deep overburden, it is suggested that a cheaply operated tool capable of sampling close to the bedrock-overburden interface be developed.

RESEARCH AREA TWO : ORE PROCESSING

Scattered throughout the EC territory are a number of low grade ore deposits. These deposits are known to contain considerable reserves of metal. It is likely that they will have to be exploited in the relatively near future.

Similarly, complex ores - such as mixed copper-lead-zinc sulphides and oxidized ores or some aluminous minerals - are considered as important potential sources of metals. Yet they remain largely unexploited, because of processing problems.

A technological breakthrough in the processing of these various ores is a vital necessity for EC countries, not only because higher grade deposits and "simple" ores are being rapidly consumed, but also for strategic reasons connected with the secure supply of critical materials.

Activities outlined hereafter are grouped into two major categories :

- II-A) Feasibility studies and setting up of models (statistical as well as for simulation), aimed at evaluating and predicting the performances of ore treatment and recovery processes (for copper, alumina and lead-zinc);
- II-B) R & D, carried to the stage of pilot plant studies, on specific ore-processing and metal recovery objectives (handling, processing and metal winning), in order to valorize low-grade ores (copper), complex ores (copper-lead-zinc) and alternative sources of alumina. The programme should develop in a sequential way, with information from the dossiers providing additional information toward activities under II-A, if appropriate, and II-B.

II-A. FEASIBILITY STUDIES AND SETTING UP OF MODELS (to be carried out mainly as concerted actions)

II-A.1. Definition of mineral processing topics

1) Low grade and complex ores

There exists already in the Community a sum of information and experience in the processing of ore from marginal deposits. However, the successful exploitation of low grade and/or complex ores calls for careful process design. Thus a sequential approach would be the best solution to get an overall view of this problem.

It would consist in :

- collating and structuring the accumulated experience of the Community's mineral processing laboratories in the area of marginal deposits, both low grade and complex;
 - R & D on the application of existing ore characterisation methods, on the development and application of new ore characterisation methods, and on integration of the information generated with the body of structured data developed;
 - progress in the development of improved processing technologies, the requirement for which has been identified previously and leading to the development of process routes.
- 2) "In situ leaching"⁽¹⁾ for recovery of non ferrous metals

It will be increasingly necessary for the EC to recover non-ferrous metals from its indigenous low grade resources in dumps, heaps, old mines and virgin ore bodies, and the relatively low cost technique of in-situ leaching is a particularly appropriate one.

Under suitable conditions, in situ leaching has the following advantages :

- reduced capital investment
- very short pre-production period
- lower pollution of land, water and air
- reduction in overall labour costs
- greater control over safety
- negligible waste disposal costs

Therefore, it is important to support an action that will provide generalised information on in-situ leaching.

3) Alumina from non conventional sources

It is essential for the Community to diversify its aluminium raw material supplies by locating alternative sources in order to increase self-sufficiency.

Alternative sources consist in : leucite, alunite, clays, schists, coal shales, power station ash and possibly other aluminous minerals.

(1) In situ leaching can be defined as the use of solutions to extract metals from fractured or unfractured ores. It is finding important uses, mainly in the U.S.A., for the recovery of copper and uranium.

EC studies should include :

- an assessment of the state of the art in the member states and in non EC countries;
- evaluation of acid leaching processes to recover alumina and by-products;
- preliminary analyses of chlorination processes.

4) Lead-zinc complex ores

EC shortage in lead and zinc minerals is important. There clearly is a need to achieve maximum integral use of every possible reserve, e.g. essentially sulphides and oxidized ores.

It is suggested to work out a mathematical simulation model of the flotation process of complex sulphides and to undertake feasibility studies on the flotation response of oxidized ores.

II-A.2. Optimization of mineral production systems, connected with possible mining operations

This would follow after the projects described under II-A.1. The main target of such an action is to work out the technical and economical feasibility of projects concerning possible mining operations, as well as to optimize the production process by selecting the best alternative.

The optimization of the production planning should be based on:

- an estimation of the mineral potential on a statistical basis;
- a simulation model of the production sequences, according to the ore deposit features and to the adoptable mining methods;
- a simulation model of the material flow in the ore dressing plant, to optimize the quality and quantity of the final product, with special care devoted to flotation processes;
- checking and continuously up-dating of the ore deposit model by feed back of the data coming from the various production phases;
- stock homogeneization and control at different levels of production;
- transport planning at the different phases;
- regulation and control of the single phases of mining and ore dressing operations.

The methodology suggested seems to offer important advantages in operating sets of small ore-deposits whose economic exploitation is only possible through a strict control of the single phases of production.

II-B. R & D ON SPECIFIC ORE PROCESSING AND METAL RECOVERY OBJECTIVES

II-B.1. In situ leaching

It is well known that for its copper supply, the Community depends both on developed and developing countries. Moreover, to meet future demands in the Community and in other industrialized countries, lower and lower grade ore deposits will have to be exploited.

The technique of in situ leaching appears very promising and there is a need to improve the technological know-how of the member countries. As an example, the large copper deposit of Avoca (Ireland), with considerable reserves of low grade ore, seems a most appropriate site for launching such an R & D action. Moreover this action is important for the following reasons :

- a) if the R & D is successful, a large deposit of copper could be economically exploited;
- b) the results of this activity could be applicable with minor modifications to other low grade deposits in the Community.

A joint team of member countries experts is expected to be created in order to share experience and knowledge in carrying out this pilot project.

II-B.2. Alumina from non conventional sources

The available data reveal an existing shortage of alumina, for the Community production covers less than 1/3 of consumption.

It is well known that the actions of the "International Bauxite Association" are leading to increased prices of bauxite and aluminium. Moreover raw materials producing countries are no longer willing to renounce the added value for bauxite processing and thus are requesting higher and higher royalties. As mentioned on page 21, it appears therefore essential to diversify the raw material supplies by locating alternative sources of alumina, in order to increase the self-sufficiency of the Community, and to support R and D activities to secure later an indigenous supply.

The major alternative sources of alumina could be leucite, alunite, clays, schists, coal shale, power station ash and other aluminous minerals. Large deposits of these alternative sources are present in the Community.

For instance, specific R & D actions will be conducted in relationship to alunite and leucite. These actions are very important for the following reasons :

- a) if the R & D is successful, large deposits of aluminium could be exploited, increasing EC self supply with resulting improvement of the raw materials payment balance of the member states;
- b) the results of this activity could be applicable with minor modifications to other deposits outside of the Community - which consequently will improve the possibility of exporting newly developed technologies.

A joint team of member countries experts is expected to be created in order to share experience and knowledge for the benefit of the member countries.

II-B.3. Lead-zinc complex ores

The EC shortage in lead-zinc minerals demands an effort of R & D. This effort has to be based on the large deposits which exist in the member countries. Generally, these are of a complex nature and demand advanced techniques for processing. Two major areas of R & D are suggested :

- a) flotation techniques for sulphide ores that are inter-grained with copper and pyrite, and for oxidized ores;
- b) hydro-metallurgy of oxidized ores using acid or alkaline advanced processes, depending upon the composition of the host rocks.

If the results are encouraging, the R & D efforts could reach the stage of pilot plants.

II-B.4. Chlorination processes and other valorization methods

Large amounts of slags and residues from metallurgical plants exist in the various member countries of the Community. These residues and other deposits sometimes constitute interesting materials which, if an advanced process could be developed, would bring into the market large quantities of metals such as copper, lead-zinc and others.

An R & D action could be based on high temperature treatment of the materials (slags, residues for example), by electrolysis or using gaseous mixtures.

RESEARCH AREA THREE : MINING TECHNOLOGY

There are strong political and economic reasons to promote a more exhaustive exploitation of known mines through an improvement of mining technology. Furthermore, progress in the field of mining technology can be the decisive factor that will enable a previously non-economic mine to be exploited. The problems that must be faced are particularly challenging with deep mines and with high grade - low tonnage deposits. As a first step, it is therefore suggested to work on those topics. At the stage of mining itself, the problems linked to environment, such as dust, subsidence and water, would also be considered.

III-A. Deep deposits

In deep mines, maintenance and operating costs are very high. Progress in technology could reduce these expenses and increase ore recovery. Among the main topics that deserve special attention, are the following :

- rock mechanics : research on rock behaviour should encompass an investigation of different rocks at simulated conditions of depth and the determination of the principal characteristics of these rocks. In parallel, the various values obtained in the laboratory must be correlated to observations and measurements in a mine. Suitable methods can then be worked out to improve support of the cavities.
- water drainage : it is necessary to study the permeability and structure of country rocks in the hope of containing water seepage; special care will be given to the consequences of cementation and cement fillings, and to the development of techniques adapted to the severe and costly working conditions.
- high temperatures : problems arise during the exploitation of some deep mines, because of the high temperatures resulting from a high geothermal gradient and from high heat transfer coefficients of the geological formations.

R & D on this topic should consider the following points :

- bringing into focus the main parameters which affect the climatic conditions in the mines, as well as acquiring a clear knowledge of the matter.
- developing a simulative model of the evolution of thermal energy transfer during the various phases of the production process.
- studying the evolution of the main parameters which affect the environment, and revising the model, if necessary.

- . determining parameters such as conductivity and radiation coefficients of the geological formations.
- . studying the measures required in order to modify the rate of heat release into the environment.
- . studying the stoping techniques and ventilation circuits so as to control the balance of heat quantities released.

III-B. High grade-low tonnage deposits (in part as concerted action)

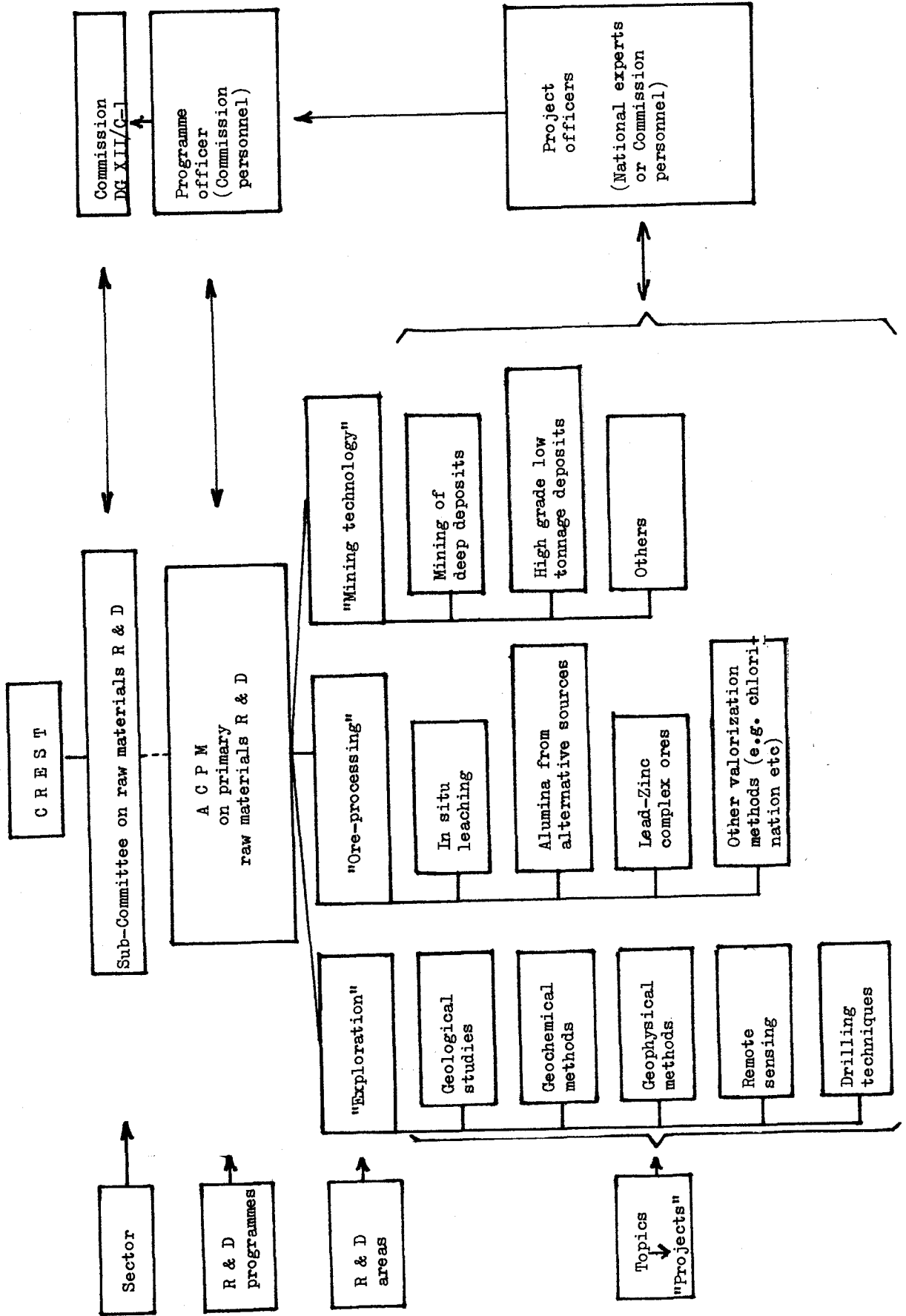
Reduction of investment and operating costs will always be an essential aim of R & D on mining technology. It is particularly important in the case of high grade-low tonnage deposits of such non-ferrous metals as copper, lead, zinc, etc, for which economic and practical mining techniques must be found. A step by step approach to the problem could comprise :

- a definition of the notion of high grade - low tonnage deposits; this is essential, because deposits form a continuous sequence from small to large, from low grade to high grade
- an inventory of known deposits of this type; such an enquiry will necessitate close cooperation between companies and geological surveys of the Member States (to be carried out as a concerted action)
- a study on the use of integrated mobile plants, aimed at finding an economic route to mine groups of comparable small-size deposits, mobile units, designed to be used on several mines in succession, could provide an adequate answer
- a study of large diameter Rotary drilling, especially for shaft sinking
- R & D on total recovery of pillars left after mining by the room and pillar method, and on the adequate materials needed to fill up the mine (this last item deals also with rock mechanics, see III-A. above).

ANNEX I

Scheme for management of raw materials R & D programmes

SCHEME FOR MANAGEMENT OF RAW MATERIALS R&D PROGRAMMES



TASKS

Sub-Committee on raw materials R & D

- Coordination of national and Community R & D activities
- Liaison with bodies involved in formulating and implementing Community supply policy in raw materials
- Overall supervision of R & D programmes in raw materials
- Programme reviews and revisions
- Formulation of new programmes

A C P M (Advisory Committee on Programme Management)

- Establishment of priorities
- Assessment and selection of proposals
- Allocation of funds
- Evaluation of research progress and results
- Preparation of programme reviews and revisions (proposals to Sub-Committee)

TASKS

- Programme officer
- supervision and coordination of the programme on behalf of the Commission
 - representation of the Commission in ACPM, scientific secretariat of ACPM
 - preparation and management of research contracts for the programme
 - exchange of information among contractors in cooperation with Project Officers

Project officer

- coordination of research undertaken under the contracts pertaining to the project
- exchange of information among contractors of the project
- preparation of progress reports and assessments of results from the project

PROPOSAL FOR A COUNCIL DECISION ADOPTING A
MULTIANNUAL R & D RESEARCH AND DEVELOPMENT
PROGRAMME IN THE FIELD OF PRIMARY RAW MATE-
RIALS (INDIRECT ACTION) 1978-1981, FOR THE
EUROPEAN ECONOMIC COMMUNITY

THE COUNCIL OF THE EUROPEAN COMMUNITIES having regard to the Treaty establishing the European Economic Community and in particular Article 235 thereof

having regard to the proposal from the Commission
having regard to the opinion of the European Parliament
having regard to the opinion of the Social and Economic Committee

- whereas article 2 of the Treaty establishing the European Economic Community assigns to the Community the task of promoting throughout the Community a harmonious development of economic activities, a continuous and balanced expansion and an accelerated raising of the standard of living;
- whereas in its resolution of 14 January 1974 on a first action programme of the European Communities in the field of science and technology, the Council has stipulated that the whole range of available ways and means should be use as appropriate, including the indirect action;

- whereas the Community, as indicated in the communication from the the Commission COM 50(1975) "The supply of the Community in raw materials", depends to a great extent from third countries for its mineral raw materials supply, that these materials will become increasingly scarce at global level and thus that the Community's interest is to increase its self-supply potential and to improve the technologies for the exploration and exploitation of mineral resources;

- whereas a Community research action in the field of primary raw materials will contribute effectively to the achievement of the above-mentioned objectives, particularly through the discovery of new exploitable internal resources as well as through the development of exportable techniques and technologies;

- whereas the European Parliament has adopted on 19 April 1977 a resolution on the supply of raw materials of the Community;

- whereas the Treaty establishing the European Economic Community has not provided the necessary powers;

- whereas the Scientific and Technical Research Committee (CREST) has given an opinion with regard to the proposal from the Commission;

HAS DECIDED

Article 1

A programme of research and development for the European Economic Community in the field of primary raw materials shall be adopted in the form set out in Annex A to this Decision for a four-year period from 1 January 1978.

Annex A forms an integral part of this Decision.

Article 2

The upper limit for expenditure commitments and for staff necessary for the implementation of this programme is estimated to be 23 million units of account and 11 staff for the duration of the programme. The unit of account is defined according to financial regulations in force.

Article 3

The Commission shall ensure that the programme is implemented. To assist it in this task an Advisory Committee on Programme Management in the field of primary raw materials is established. The terms of reference and the composition of this Committee are stated in Annex B to this Decision.

Article 4

The programme will be submitted to review, during its third year, for possible revision following established procedures, and taking into account the opinion of the Advisory Committee for Programme Management.

Article 5

The information resulting from the execution of the programme shall be disseminated in accordance with Council Regulation (EEC) n° 2350/74 of 17 September 1974, adopting provisions for the dissemination of information relating to research programmes for the European Economic Community.

ANNEX A

Research area I : Exploration

- I-A- Deep-seated and concealed ore deposits in the territory of the European Community :
 - target selection through the improvement of applied geological knowledge
- I-B- Improvement and development of prospection methods and techniques
 - I-B-1 - geochemical
 - I-B-2 - geophysical
 - I-B-3 - remote sensing
 - I-B-4 - drilling techniques

Research area II : Ore processing

- II-A- Feasibility studies and setting up of models
- II-B- Specific R & D actions in ore-processing and metal extraction
 - II-B-1 - in situ leaching
 - II-B-2 - alternative sources of alumina
 - II-B-3 - complex lead-zinc ores
 - II-B-4 - chlorination processes and others

Research area III : Mining technology

- III-A- Deep mines
- III-B- High grade-low tonnage deposits

Research work will be carried out by way of contracts.

ANNEX B

Terms of reference of the Advisory Committee for the Management of the R & D Programme in the field of primary raw materials

1. Without prejudice to the responsibility which the Commission has for the execution of Community programmes, the Committee has the task of contributing, in its advisory capacity :
 - to the optimal carrying out of the R & D programme in the field of primary raw materials, and in particular to the detailed definition of projects as well as the assessment of results;
 - to the gradual co-ordination of all Community and national research activities within the area of primary raw materials.

2. The Committee formulates opinions, prepared by the Secretariat and submitted to approval by the Committee. Every Committee member can ask that his opinion be recorded in these opinions. These opinions are transmitted to the Commission and a copy to the Council. CREST and its Sub-Committee will be informed periodically on the work of the Committee.

3. The Committee includes :
 - for the member States delegations, a maximum of three members, appointed by their governments for the duration of the programme and having regard to their competence in the matter; as far as possible, one of them should be responsible for the national R & D programmes in the field of primary raw materials; if it considers it necessary, each delegation may be accompanied by experts;

- for the delegation of the Commission, a maximum of three officials appointed by this institution.

Exceptionally, these conditions can be departed from with the agreement of the delegations.

4. As far as the delegations from the member states are concerned a member's mandate ceases should the member decease or resign, or if the government who appointed him asks that he be replaced. His successor is appointed for the remainder of the initial term of office.
5. The Committee appoints its chairman, on the proposal of the Commission's delegation and for a period of one year.
6. The Secretariat of the Committee will be provided by the Commission.

FINANCIAL DATA
established for financial 1978
Annex I of budget of the Commission
Statement of receipts and expenditures
relating to research and investment
activities (indirect action)

A. FIRST PART : ON-GOING OR NEW ACTIONS

1. BUDGET CHAPTER : 3361

2. HEADING OF THE BUDGET TIME : Research programme in the field of primary raw material (indirect action 1978-1980)

3. JURIDICAL BASIS : Article 235 of EEC Treaty
Council Decision

4. DESCRIPTION, OBJECTIVES AND JUSTIFICATION OF ACTION

4.1. Description :

Primary raw materials

Research programme carried out by means of cost-sharing contracts with research organizations in the member states, in the three following research areas :

- 1) Exploration : Emphasis is laid on the detection of concealed and deep seated deposits
- 2) Ore-processing
- 3) Mining technology

4.2. Objectives :

R & D aimed at :

- 1) increasing the self-supply potential of the EC in non-ferrous metals, phosphates, etc...
- 2) developing new techniques for use by the EC mining industry within and without the territory of the Community.

4.3. Justification :

Actions carried out at Community level optimize the productivity of research undertaken in the member states, by avoiding useless duplication and filling gaps. They also make it possible to concentrate the potential of the research organizations in the member states on problems of common interest and facilitates the development of advanced technologies.

5. FINANCIAL INCIDENCE OF ACTION (IN EUA) :

5.0. Incidence on the expenditure

5.0.0. Multiannual term

Commitment

	1978	1979	1980	1981	1982
Staff	277.300,-	488.592,-	524.784,-	560.976,-	--
Manag.	126.900,-	137.052,-	147.204,-	157.356,-	--
Contracts	7.595.800,-	9.374.356,-	3.609.680,-	---	--
TOTAL	8.000.000,-	10.000.000,-	4.281.668,-	718.332,-	--

Payment

	1978	1979	1980	1981	1982
Staff	277.100,-	488.592,-	524.784,-	560.976,-	--
Manag.	126.900,-	137.052,-	147.204,-	157.356,-	--
Contracts	1.596.000,-	3.374.356,-	6.328.012,-	8.281.668,-	1.000.000,-
TOTAL	2.000.000,-	4.000.000,-	7.000.000,-	9.000.000,-	1.000.000,-

5.0.1. Evaluation method
(included multiannual previsions)

a) Staff expenditure

The needs are estimated to be 7 staff for 1978.
and a maximum of 11 staff for the next years, i.e.

1978

4 category A staff
1 category B staff
2 category C staff
7 staff

Maximum

7 category A staff
1 category B staff
3 category C staff
11 staff

In addition to staff number estimates, the evaluation take account of the data of the Council Decision of 21.12.1976 on the adaptation of salary of European Community staff and applicable correction coefficients adding to it-on a hypothetical basis - possible needs originating from the general evolution of prices in the Community.

The rates adopted are those used for the calculation of the three-year forecast 1978/1980. The evaluation of expenditure increases up to 1981 has been made on the basis of the following indices : 1978-108, 1979-116, 1980-124, 1981-132.

b) Contracts expenditures

In view of the nature of the subject and the qualification of the contractors, a uniform method of the evaluation cannot be established.

In any case, the Advisory Committee, provided by the Draft Decision (art.3) will be consulted on the allocation of funds.

5.0.2. Time-table of use of payments accounts for 1978.

1st Trimester	2nd Trimester	3th Trimester	4th Trimester
335.000	335.000	835.000	495.000

5.1. Possible financial incidence of action on the Funds

6. CONTROL SYSTEM (including efficacy control)

Scientific control : Advisory Committee on Programme Management

Financial execution : Financial control

The contract service of DG XII controls yearly the expenditures of the contractual partners.

B. SECOND PART : SUPPLEMENTARY INFORMATION FOR NEW ACTIONS*

7. TOTAL FINANCIAL INCIDENCE OF ACTION DURING THE TERM ENVISAGED (en EUA)

7.0. Funded :

- on Community budget 23.000.000 EUA
- by national administrations 21.000.000 EUA
- by other sectors at national level ...

Total 44.000.000 EUA

7.1. Incidence on the funds

- Community income tax on staff
- Functionaries contribution for retirement fund

* the Commission decision of 28 november 1973 on new orientations in financial matters mentionsthe requirement to establish for a new action a "financial memorandum" made up of the two parts of the financial data sheet.

8. INFORMATION ON PERSONNEL

8.0. Personnel of any category required for the exclusive implementation of the action

1978	7 staff	see 5.0.1.
1979-1981 maximum	11 staff	" "

8.1. Possible supplementary staff to be requested for this action ; the possibilities of reassignment of staff to the Directorate General being considered

9. FUNDING OF ACTION

9.0.

9.1.

9.2.

9.3. Funds to be included in future (s) budget (s).