GEOPHYSICAL EXPLORATION OF MINERAL RESOURCES IN BRAZIL

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ABSTRACT

Release of this paper bearing special emphasis on aerogeophysical surveys, means to make known to all the attempt carried out by the Federal Government through the Mineral Resources Exploration Company - CPRM, to promote the discovery and to develop the occurrences of Brazil's mineral resources.

Proceedings specifically adapted for contracting specialized companies in the field of geophysics, CPRM's activities and statistical data from study programs as well as financial investments are included in the present paper.

Over than 500,000 linear kilometers of aerogeophysical surveys have already been produced by CPRM in the past four years and there are possibilities for more than 800,000 linear kilometers to be flown in 1975/76 which will requires an investment of approximately 15 million dollars.

INTRODUCTION

The Mineral Resources Exploration Company - CPRM - a part-private, part-government concern jurisdictioned to the Ministry of Mines and Energy of Brazil, was founded in 1969 for the purpose of promoting the exploration of mineral and hydric resources throughout Brazil.

The political-administrative framework within which it was conceived and created considering that an economic and financial balance to be maintained in all its fields of activity, CPRM set out right from the start to organize itself to perform three basic lines of action, which can be summarized as follows:

As a Service Company, to carry out those services requested by government agencies and by the private sector through of service contracts;

As a Mining Company under the Brazilian Mining Code, aiming at supplementing private initiative, not beyond the field of mineral exploration;

As a Finance Company, to encourage mining activity in the country, through loans to brazilian mining companies lacking adequate means to carry out detailed exploration works into existing mineral deposits offering government financing in such ventures, CPRM may provide up to 80% of the total cost of the exploration with the inclusion of a risk clause or without it.

As a Service Company, CPRM has been carrying out such work as Geological Mapping and Surveying, Geochemical Investigation, Chemical and Spectrochemical Analysis, Aerogeophysical Studies, Ground Geophysics, Geophysical Well Logging, Diamond Rotary Drilling, Hydrology Services, etc. These activities are utilized in mineral and hydric resource investigation projects in Brazil, upon request from the government agencies, such as the National Department of Mineral Production - DNPM; the National Department of Water and Electric

Energy - DNAEE; the National Commission of Nuclear Energy - CNEN; the North-East Development Agency - SUDENE; the Amazon Development Agency - SUDAM.

In june 1970, when CPRM started operating, it was also given the responsibility of implementing the Brazil-Germany Geophysics Agreement in the State of Minas Gerais. All matters related to the application of this science to the field of mineral exploration then focused on this agreement.

In view of the special nature of aerogeophysical work, which requires an extensive capital outlay in the form of aeroplanes and equipment, CPRM considered it advisable to rely on the co-operation of specialized firms in the country and their experience has contributed to carrying out successful projects.

The lack of a technical background in Brazil, in the field of electrical logging in uranium exploration, led CPRM to exert every possible effort to encourage geophysical companies to become actively involved in this type of activity and to import suitable equipment.

At the same time, CPRM proceeded to import from the United States logging units, in order to carry out the projects requested by the National Commission of Nuclear Energy. Due to the sharp increase in drilling in uranium exploration, these projects have demanded a growing effort.

With the purpose of uranium exploration, 40 portable radioactive measuring instruments for use in field work were imported, namely 30 Scintillometers and 10 Gamma-ray detection

instruments from FRANCE. In the same period 20 Scintillometers were ordered from Microlab Eletrônica LTDA, thus trying to safeguard and encourage the interest of brazilian companies specialized in manufacturing electronic equipment used in mineral exploration.

CPRM, as the executive party of the agreement between the Ministry of Mines and Energy and USAID, has also been able to count on the support of the USGS geophysicists in the training of personnel and in the provision of ground geophysics equipment, which has made it possible to carry out experimental work in the chrome and copper mining regions, both in the State of Bahia.

BRAZIL-GERMANY GEOPHYSICS AGREEMENT

The Brazil-Germany Geophysics Agreement, CGBA, is a follow up to the Basic Technical Co-operation Agreement, which was signed by the Governments of Brazil and the Federal German Republic in Bonn in november 1963, for the purpose of promoting geological and geophysical surveys in areas of the States of Minas Gerais and Espirito Santo, covering an area of 562,000 square kilometers located east of 48º longitude and west of the city of Victoria.

The German Government, through the "Bundesanstalt für Bodenforschung - BfB", contracted the Hannover firm of "Prakla Seismos" to undertake the systematic aerogeophysical surveys, while the Brazilian Government, through the National Department of Mineral Production - DNPM, contracted the Mineral Resource Exploration Company - CPRM - to fulfill the brazilian duties in

of the agreement in january 1971.

The sequence of work being carried out by the CGBA and which meet the objectives laid down in Article 1 of the Agreement may be summarized as follows:

a. Setting up the operational infrastructure through the selection os airports, gathering of meteorological data, setting up the support system, the selection of brazilian technicians, the establishment of a head-office, etc.

b. Systematic aerogeophysical surveying through magnetometric and scintillometric measurements.

c. Complementary aerogeophysical surveying using helicopters in areas of aeromagnetic anomalies including the use of eletromagnetic measuring methods.

d. Further studies of areas found promising in previous investigations, with additional land geophysical exploration, through the application, in accordance with the peculiar characteristics of each problem, of magnetometry, scintillometry, gravimetry or geoelectric methods of measurement.

e. Geological Cartography and exploration of mineral deposits found.

The systematic aerogeophysical surveys began on 1971, using two Aero-Commander 680F equipped with a Geometrics Proton -type high-sensitivity magnetometer, an Exploranium four-channel spectrometer and auxiliary data-collecting instruments, such as registers and date loggers, 35 mm Strip Camera to photograph the area flown over, besides radio-altimeter and doppler.

The aeromagnetometric surveys were carried out by means of systematic flights in the general east-west and north-south directions, in spaced-out lines of, approximately, 2 and 20 kilometers, respectively. The magnetic data were collected at a constant altitude, constant in relation to sea-level, which corresponds to a flight altitude of between 300 - 400 metres, taking into consideration the 26 zones of uniform relief, into which the overall survey area was divided.

In the areas where the topography was relatively flat and where consequently the problems of altimetric corrections presented no difficulty, profiles were taken with simultaneous magnetometric and scintillometric measurements.

As previously been noted the overall area designated for this first stage (CGBA-MG) is 562,000 square kilometres, which corresponds to 340,000 linear kilometers of aeromagnetometric flights, and the plan for the aero-scintillometric survey, depending on more detailed studies of the relief of the zones to be flown over, is 120,000 kilometers.

This systematic aeromagnetometric survey in this first stage should be completed by December 1974, with the coverage of the total area provided for in the terms of the agreement and preliminary surveying of the most important aerogeophysical anomalies.

The aeromagnetic information obtained in this first stage were processed in the Prakla - Seismos Data Computation Centre in Hannover, by a mixed group of brazilian and german technicians.

The result of this procedure has been to provide practical training for brazilian engineers and geologists in the techniques of data operation, processing and interpretation.

At the same time where the systematic aerogeophysical survey is being carried out, technicians are being trained in the operation and maintenance of geophysical equipmento, pilots and service men in the flying and maintenance of aircraft and technicians in support services including flight planning and treatment of data obtained.

After processing the information collected in this first stage, the maps of iso-anomalies are constructed on a scale of 1:500,000.

The interpretation of the maps of iso-anomalies, done in Hannover by the BfB in co-operation with brazilian technicians, enable the selection of magnetic anomalies which are being investigated by ground geophysical methods and through geological and geochemical surveys. The ground geophysical methods include the use of Magnetometry, Scintillometry, Electrical Methods - Induced Polarization (IP), Spontaneous Potential (SP), and Electro-resistivity and Electro-magnetic Methods such as: Turan, slingram and Very Low Frequency (VLF).

For the detailed aerogeophysical studies, which in a logical sequence correspond to a second stage, use is being made of a Sikorsky H-34 helicopter, which is equipped to carry out electromagnetic measurements with the new radiophase system developed by Barringer of Canada, together with equipment for

scintillometric and magnetometric measurements.

The final stage of the work to be executed under the agreement will consist of detailed geological cartography in the areas considered promising, after the application of the above-mentioned geophysical methods.

In the last year the CGBA has been requested to carry out an aerogeophysical survey the State of Goiás, a total of 45,000 linear kilometers of magnetometry combined with aerogamma -ray spectrometry. This work, called CGBA (GO) is undertaken entirely by brazilian technical personnel, who were trained during the first stage in Minas Gerais.

When the activities of the group of german specialists in Brazil have been completed, the equipment, laboratories and aircraft will be taken over by the Brazilian Federal Republic and placed at the service of the Ministry of Mines and Energy, with the aim of giving continuity to the geophysical investigations in Brazil. Thus, CPRM has already planned to establish a Geophysics Center to make full use of the experience accumulated during the activities of the current agreement.

Tables 1 and 2 and the map enclosed show the characteristics and location of CGBA (MG) and CGBA (GO).

BRAZIL-CANADA GEOPHYSICS AGREEMENT

In harmony with the goals set by the Ministry of Mines and Energy, arising from the need to develop the mineral sector of the country, by means of a rapid increase in the knowledge of its sub soil, a series of steps were taken in 1971 to set up a technical co-operation agreement between the

Brazilian Government and the Canadian Government.

Due to the inherent geological characteristics of each region, the conventional work of basic geological mapping is not always sufficiently adequate to provide the necessary support for specific local investigations. Parallel programs of systematic Geophysical and Geochemical Surveys, on a regional scale, are frequently necessary for the location of mineral-bearing bodies or structures.

It is, however, precisely in the development of these prospecting methods that we very often run into insuperable problems, arising from the lack of necessary technical know-how, equipment and infrastructure for the undertaking of this research. In such situations, the frequently adopted solution consists of joining the capacity of national enterprises to the experience of traditional mining countries in the from of technical co-operation agreements.

Therefore, considering the interest of the Ministry of Mines and Energy in carrying out a complete assessment of the mineral ressources of an area of approximately 300,000 square kilometres, situated in the central region of Brazil, there is full justification for the utilization of foreign know-how through a technical co-operation agreement with Canada, a country which has undertaken in the last ten years extensive programs of regional aerogeophysical surveys.

With the end of this important technical co-operation agreement a number of results are expected, the most significant of which are as follows:

a. integration and revision of the geological knowledge of the area;

b. general assessment of mineral potential, with major importance being given to nickel and the definition of mineral potentialities up to the level of mineral-genetic provinces and districts;

c. the development, in an experimental character, of methods of geophysical and geochemical prospecting, suitable to the geological and morpho-climatic characteristics of the region;

d. emphasis is given to the training of Brazilian technicians in all the methods of prospecting that are used and the assimilation and adaptation of Canadian know-how to Brazilian requirements.

The Brazil-Canada Geophysics Agreement - CGBCA - was considered top priority by the Ministry of Mines and Energy and the work is due to start in 1975.

Tables 1 and 2 and the map enclosed show the principal characteristics and the intended location for this CGBA.

AEROGEOPHYSICAL SERVICES CONTRACTED

To meet all the requests for aerogeophysical projects received from the National Commission of Nuclear Energy, the National Department of Mineral Production, and other agencies, the CPRM has used and is using in the form of contracted services, the co-operation of specialized firms operating in Brazil, after undertaking a competent technical assessment of

all those registered with the company.

Four brazilian firms plus one american were contracted to execute those services which cost over than US$10,000,000.00.

Those firms are: LASA, Engenharia e Prospecções S/A; PROSPEC S/A, Geologia, Prospecções e Aerofotogrametria: Geofo to S/A; Companhia Brasileira de Geoffsica - CBG and Texas Instruments Incorporeted (TI).

From 1970 till now the following work has been or is to be carried out: approximately 761.659 linear kilometers of aero-gammaspectrometry and/or aero-scintillometry and 726.015 linear kilometers of magnetometry as given in tables 1 and 2 and the location map enclosed.

For the services contracted by CPRM of systematic aerogamma-spectrometry and aeromagnetometry now being undertaken in Brazil, the following technical specifications, among others, are demanded:

a. The lines of flight should be parallel, equidistant and routed beforehand on semi-controlled photo-mosaics to the scale 1:50,000 based on recent aerial photographs.

b. The lines of flight must not diverge from the prescribed route by a distance of more than 25% of the spacing between the theoretical lines of flight in a stretch of over 5 kilometres. When it is not possible to observe this specification, the gap will be filled by a line of flight at the expense of the company carrying out the work.

c. Production flights may not be made over areas where there has been pluviometric precipitation until at least 48 hours

have elapesed.

d. Due to the problem of radon accumulation in the layer of atmospheric inversion, flights will not be permitted before 9 a.m., unless there is evidence that the result would be acceptable.

e. The flight altitude should be 135 metres, with a maximum permissible variation of between 105 and 165 meters above ground level.

f. The instrument system to be used in the airplane must be of proven quality, submitted to the approval of CPRM and able to meet the following requirements:

1. It should register radiometric phenomena on the surface of the earth, discriminating between the four conventional channels, that is to say, thorium, uranium, potassium, and the total sum, with an integration constant of 2 seconds.

2. It should have a minimum detector volume of 13,110 cubic centimeters, approximately equivalent to 800 cubic inches - in the case of NaI (TI) detectors, and of 52,717 cubic centimetres in the case of plastic detectors.

g. The fiducial number information, date, time of measurements and all the values of the profiles, must be registered digitally on board the airplane and compatible with IBM/360 computers.

h. Prior to carrying out the survey lines, a daily flight should be made at an altitude of 2,500 feet over the same spot, for the sole purpose of obtaining the sum total of the degree of

radiation emitted by the aircraft and other factors that may affect the system.

i. The total magnetic intensity of the earth's magnetic field must be obtained by a Flux Gate or Proton type magnetometer with a 1 Gamma accuracy.

j. The system of measuring the earth's magnetic field must have the capacity to record every 2 seconds, or at a greater frequency. The magnetic noise must not exceed 2 Gammas.

k. A magnetometer at a fixed base station must be used to register the daily variation of the earth's magnetic field.

BORE-HOLE LOGGING

To carry out uranium prospection projects requested by the National Commission of Nuclear Energy, CPRM co-operated with firms specialized in bore-hole logging through service contracts, at the same time as it imported from the United States 9 medium-size logging units, specially selected to meet the requirements laid down by CNEN for this type of service, as previously noted.

With the sharp increase in the number of drillings in uranium prospecting, in 1970 to 1973, great efforts were necessary to ensure that the logging could be adequately carried out, seeing that brazilian geophysical companies were unprepared, in the short run, to take part of the work. It should be added that before the creation of CPRM only CNEN was working in this field and at a much slower pace than that established in Brazil since 1970, which helps to explain the initial difficulties.

To carry out the bore-hole soil profiling involved in some projects of the National Commission of Nuclear Energy, the services of Schlumberger, the Brazilian Geophysics Company, and Dames & Moore were contracted.

Schlumberger employed their standard gamma-ray and electric logging equipment.

The Brazilian Geophysics Company, using portable Mount Sopris - 1,000 equipment, carried out services of gamma-ray and electric logging, including SP register and Single Point Resistivity.

Dames & Moore, an American consulting Firm, at the request of CPRM, took part in the gamma-ray logging using semi-portable WIDCO equipment.

Relatively to gamma-ray logging, a number of technical specification have to be met, among which it is worth mentioning the following:

a. The logging equipment should be divised to allow a linear relation between all the measures bearing a dead-time of less than 10 micro-seconds.

b. The gamma-ray logging should use alkaline halite crystals, with minimum dimensions of 1/2 inch by 1/2 inch.

c. The maximum diameter of the logging probe has to be 58 millimetres for holes where gamma-ray and resistivity logging are to be carried out simultaneously.

d. The sensivity scales of the gamma-ray logging equipment should be such that the second is two to five times greater

than the first, and so on, there having to be a linear relation between all the scales, with a maximum permitted variation of 5%.

e. The divisions on the register paper must be in the metric system and the required depth scale 1:100.

f. The gamma-ray logging equipment should be devised to permit register with a maximum speed of 5m/minutes. In the case of gamma-ray re-logging of anomalous radioactive stretches, the speed is 1.5 meters/minute.

g. In the case of electric logging, the register of the SP and of the resistance (Single Resistivity Point) is required.

MARINE GEOPHYSICS

The Global Survey Program of the Brazilian Coast is being undertaken by the Ministry for the Navy (DHN), the Ministry of Mines and Energy (CPRM, PETROBRÁS and DNPM) and by the National Research Council, together with LAMONT DOHERTY GEOLOGICAL OBSERVATORY (LDGO) of the University of Columbia and the WOODS HOLE OCEANOGRAPHIC INSTITUTION (W.H.O.I.), both of the United States.

The work is being performed in three stages, including a preliminary phase of training and data compilation.

In the preliminary phase, the work was carried out in conjunction with WOODS HOLE where at brazilian technicians do the work of compiling the data already available. Five brazilian technicians, including a CPRM's geologist, took part in a cruise along the Atlantic Coast of Africa, where WOODS HOLE development

a similar program similar to that to be done along the brazilian coast. This phase lasted until September 1972.

The first stage, in association with LAMONT was sailed between March 1972 and April 1973. In this cruise, geographical information was collected in areas not covered by previous expeditions between Recife and Chuí. Geophysical work along 15,000 kilometers comprising seismic, gravimetric and magnetometric profiles were besides precision bathymetric profiles with the interpolation of various scientific stations.

The second stage (November 1973 to April 1974) consisted of the so-called WOODS HOLE Shallow Water Cruise, and was carried out between Orange Cape and Chuí. It consisted of surveys of the continental shelf and slope, including the mapping of the sea-surface distribution of rocks and sediments, gathering information about the present morphology of the shelf, clarification of its shallow structure and of the slope, the survey of the oceanographic parameters (currents, properties of the water, etc.), and the possible location of mineral concentrations of economic interest.

Activities including precision bathymetric survey; shallow seismics; ocean-bed sampling at intervals of between 10 and 18 kilometers or less, giving a total of about 1,500 samples and a collection of physical and chemical oceanographic data, were undertaken along 20,000 kilometers.

The third and last stage (January 1974 to February 1975) called the WOODS HOLE Deep Water cruise, will also extend from Cape Orange to Chuí.

This phase of the work it is intended to widen previous surveys of the slope sections and sea-bed viewing to provide an integrated picture of the brazilian coast.

With the use of essentially geographical methods and scientific stations, it is itended to study the extend of the sedimentary basins of the continental shelf, describing the seaward-facing sides; to indicate potentially economic areas for the accumulations of hydrocarbons and other mineral deposits; to obtain better control of the deep and shallow structures in areas of difficult interpretation, as already outlined in the previous stages, and a better geological control to clarify the structural evolution of our coastal basins in relation to that of the South Atlantic oceanic basin.

Transversal profiles along 40,000 kilometers of the coast will be executed some stretching as far the Mid-Atlantic chain, consisting of the following geophysical work: seismic reflection and refraction, magnetometry, gravimetry and precision bathymetric profiling. Besides this work, scientific stations will be set up for ocean-bed sampling and oceanographic measurements.

In all three operational stages, parallel to the work at sea, the analysis and interpretation of the data obtained will be carried out on land, in the U.S.A. and in Brazil.

GROUND GEOPHYSICS

Besides the work of land geophysics that is being carried out in the States of Minas Gerais and Espirito Santo by

CGBA, note should be taken of CPRM'S experimental work using this technique in other places of interest for mineral prospecting.

As the executive party of the Ministry of Mines and Energy and USAID Agreement, CPRM has been able to count on the support of USGS geophysicists in the training of personnel and in the provision of ground geophysics equipment, which has made it possible to develops experimental work in the chrome and copper mining regions, mainly specific projects of interest to the National Department of Mineral Production, as previously noted.

In the chrome-ore bearing areas, in the State of Bahia, comprising the municipalities of Campo Formoso, Senhor de Bonfim, Antonio Gonçalves, Pindobaçú and Saude, the gravimetric and magnetometric methods were tried out.

In the copper-ore bearing areas in the region of the Valley of Curaçá, in the State of Bahia, magnetometric methods (total field and vertical component), gravimetric methods, Afmag, IP (Dipolo-Dipolo, Polo-Dipolo and Schlumberger) and scintillometric methods were tried.

In the assessment of reserves of monazite and other heavy minerals, seismic, magnetometric, electro-resistivity and scintillometric methods were used.

The standard method of ground scintillometry is used in the prospecting for uranium minerals.

Table 3 enclosed provides the statistical data of the ground geophysical work carried out by CPRM.

INVESTMENTS IN GEOPHYSICS

An examination of graph 1 shows that in the general computation of investments made by the National Department of Mineral Production, and by the National Commission of Nuclear Energy in their mineral prospecting services from 1970 to 1974, the share going to geophysics was 27.45%, which corresponds approximately to an investment of US$ 16,800,000.00. Of this total, we should point out that more than 90% corresponds to aerogeophysics, since ground geophysics and bore-hole geophysics constitute an insignificant part of the total expenses.

As for the activities related to uranium-ore prospecting, it can be seen from graph 2 that from 1970-1974 approximately 25.36% of the available budget was invested in aerogeophysics, which corresponds to US$ 5,300,000.00.

As for DNPM, we can see from graph 3 that in the same period, about US$ 11,500,000.00 were invested in aerogeophysical projects, which corresponds to 28.54% of the expenditure of that department.

Bore-hole geophysics represents a very small part of the expenses, although, it is closely linked with the drillings that make up 60.29% of the services of CNEN and 13.40% of the services of DNPM. In should be added, however, that the logging cost usually reaches about 10% of the price of drillongs, which explains their relative unimportance in the overall analysis.

Graph 2, on the other hand, reflects the concern of CNEN to define the value of the traces of uranium already

discovered, in view of the massive investment involved in the drilling work. This is also explained by the fact that the drilling services carried out by CNEN before the creation of CPRM were very limited, as the bulk of their efforts were concentrated in the discovery of uranium traces, for the past 10 years.

As for DNPM we may observe that there exists a ressonable balance in the distribution of expenses according to the type of service, which helps to define up to a point the general approach that has been adopted. So, the figure of 45.41% for Basic Projects reflects DNPM's concern to carry out geological infrastructure services. The figures of 8.95% for Specific Projects, 13.40% for drilling, and 28.54% for aerogeophysics reflect the other activities of this Department.

PROSPECTS FOR THE USE OF GEOPHYSICS IN BRAZIL

The international experience acquired in the last 20 years in the field of mineral exploration has shown that marked variations in the physical properties of rocks, and these variations can be detected and recorded by sophisticated instruments. As it is well known, these variations can be correlated with the geology, structure and mineralization of the areas inspected, this leading to the widespread use of geophysical methods in the exploration for new mineral deposits, mainly aerogeophysics which, thanks to its relatively low cost, makes it possible to obtain a reasonable amount of information for the large area under survey.

In vast countries like Brazil, where most of the land still remains unexplored, it is reasonable to expect in the years to come an aggressive program of regional aerogeophysical surveys to bring about in a relatively short time the discovery of new mineral wealth.

Within the exposed guideline, there is no doubt that CPRM, as a mineral development enterprise, will bear a great responssbility in the conduct of future geophysical projects, especially those related to regional surveys. As a logical consequence of the massive investment in the preliminary phase, when an initial selection of areas will be made for future investigation, new ground geophysical techniques will be used. This will permit wide development in all sectors of the auxiliary methods of mineral exploration.

Graph Nº 4 shows the position of aerogeophysical work from 1953 to 1974 excluding, abviously, the work concerned with oil prospecting.

Although being rather early for a fore-cast, it is expected that in 1975 and 1976, the total number of linear kilometers of aerogamma-spectrometric and aero-magnetometric surveys combined should reach in each year the equivalent to that carried out in 1974. It is interesting to note that normally after two or three years of intensive aerogeophysical surveys there is a slow-down which is necessary to make it possible to digest, through the use of more detailed geophysical methods, the data that has accumulated with the application of regional geophysical methods.

CPRM extended its compute processing to include geophysical data. In doing so, a considerable amount was invested in the purchose of a Digitizer and a flat-bed Plotter, which are now being installed.

The Brazil-Germany Geophysics Agreement - CGBA - still has to carry out about 45,000 linear kilometers of aero-magnetometry and aero-scintillometry in the State of Goiás. For 1975, most of the work will concentrate on ground geophysics, as already noted, to investigate and assess the magnetic anomalies discovered in the first stage.

After the conclusion of CGBA, CPRM intends to set up a Geophysics Center using all the personnel, materials and equipment, laboratories and aircraft, with a slope to maintaining the continuity of the geophysical investigations in Brazil, in this way making full use of the experience accumulated during the course of the current agreement.

The work of the Global Survey Program of the Brazilian Coast should be completely finished by February 1975.

It would be worthwile to say that CPRM has at present a group of technitians specialized in remote sensors, and their training was provided by the MME/USAID agreement, either here or abroad.

In order to make the best use of the ERTS satellite images and others remote sensing surveys, in the visible infrared and micro wave bands, CPRM acquired modern equipment, such as: Density Slicer, Viewer, Diaso and others.

At present, 50 BS graduated technitians are working on different branches of the Geophysical activities in CPRM, and several of them have already completed pos-graduation and/or advanced courses.

The resources to be put at the service of the National Department of Mineral Production and the National Commission of Nuclear Energy, coming from the Sole Tax on Gaseous and Liquid Fuels (1.3% DNPM and 1% CNEN) offer excellent prospects for the use of sophisticated geophysical techniques in the next few years. If the rate of 30% of the total resources is maintained as it was up to december 1974, this will mean an estimated US$ 10,300,000.00 for geophysical work in 1975 and 1976.

Thank You

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AEROGEOPHYSICS PROJETS
(1970 - 1974)

PROJECT	SCINTILLOMETRY and /or GAMAESPECTROMETRY (1 Km)	MAGNETOMETRY (1 Km)	CONTRACTOR
1. ACARAÚ	-	22,000	PROSPEC
2. A.GARÇAS*	34,114	34,114	PROSPEC
3. BODOQUENA	13,000	13,000	GEOFOTO
4. CAMAQUÃ*	36,720	36,720	TI
5. CGBA (MG)*	120,000	340,000	PRAKLA
6. CGBA (GO)	45,000	45,000	CPRM
7. CGBCA**	300,000	300,000	-
8. DIAMANTINA	25,000	-	PROSPEC
9. ESP.SETENTRIONAL	16,000	16,000	GEOFOTO
10. FURNAS	19,000	-	PROSPEC
11. FRANCA	6,644	-	LASA
12. IPORÁ*	48,570	48,570	PROSPEC
13. ITABERABA-BELMONTE**	79,000	79,000	-
14. ITIÚBA	80,000	80,000	PROSPEC
15. PARÚ-RIO NEGRO**	73,000	73,000	-
16. PARNAMIRIM	28,000	-	LASA
17. P.GROSSA-CRICIÚMA*	36,411	36,411	CBG
18. Q.FERRÍFERO*	11,213	11,213	PROSPEC
19. RIO DO SANGUE**	31,000	31,000	-
20. RIO GUAPORÉ**	24,000	24,000	-
21. RIO MADEIRA	28,000	-	LASA
22. RORÃIMA**	20,000	-	-
23. SERIDÓ*	25,000	25,000	LASA
24. SERRA DA MESA*	46,987	46,987	CBG
25. S. MAR SUL	80,000	80,000	GEOFOTO
26. SUL PARA	-	45,000	LASA
27. XINGÚ-ARAGUAIA*	-	14,000	GEOFOTO
TOTAL	1,401,015	1,226,659	-

* Concluded ** Predicted for 1975

TABLE 1

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AEROGAMAESPECTROMETRY AND/OR SCINTILLOMETRY PROJECTS

(1970 - 1974)

PROJECTS	1 km	Line Spacing (km)	Ground Clearance (m)	Coverage	Crystal Volume (Cubic inch)
1. FRANCA	6,644	1.0	120	24%	235
2. A. GARÇAS	34,114	1.0	120	24%	415
3. P.GROSSA-CRICIÚMA	36,411	1.0	120	24%	400
4. S. DA MESA	46,987	1.0	135	27%	400
5. Q. FERRÍFERO	11,213	0.5	135	54%	400
6. IPORA	48,570	1.0	150	30%	400
7. CAMAQUÃ	36,720	1.0	125	25%	1,575.8
8. SERIDÓ	25,000	1.0	135	27%	1,012.5
9. CGBA (MG)	120,000	2.0	250	25%	450
10. ESP. SETENT.	16,000	4.0	135	6.75%	800
11. RORAIMA	20,000	2.0	100	20%	200
12. ITIUBA	80,000	1.0	135	27%	800
13. BODOQUENA	13,000	2.0	135	13.5 %	800
14. S. MAR SUL	80,000	1.0	135	27%	800
15. CGBA (GO)	45,000	2.0	135	13.5 %	450
16. PARNAMIRIM	28,000	2.0	135	13.5 %	800
17. RIO MADEIRA	28,000	4.0	135	6.75%	800
18. FURNAS	19,000	4.0	135	6.75%	800
19. DIAMANTINA	25,000	4.0	135	6.75%	800
20. CGBCA	300,000	1.0	-	-	-
21. PARU-RIO NEGRO	73,000	4.0	135	6.75%	800
22. ITABERABA-BELMONTE	79,000	1.0	135	27%	800
23. RIO GUAPORÉ	24,000	1.0	135	27%	800
24. RIO SANGUE	31,000	2.0	135	13.5 %	800
TOTAL	1,226,659	-	-	-	-

TABLE 2

CPRM

GROUND GEOPHYSICS
(1971 - 1974)

OBJECTIVE	METHODS	LINEAR KILOMETERS	SQUARE KILOMETERS
COPPER PROSPECTING	MAGNETOMETRY	156.70	10.70
	GRAVIMETRY	18.70	1.50
	A f m g	63.20	8.16
	IP	99.00	10.79
	SCINTILLOMETRY	8.50	0.60
CHROME PROSPECTING	MAGNETOMETRY	8.40	-
	GRAVIMETRY	22.20	3.64
MONAZITE PROSPECTING	MAGNETOMETRY	5.00	0.12
	SEISMIC	0.30	-
	RESISTIVITY	0.30	-
	SCINTILLOMETRY	46.80	-
CGBA	MAGNETOMETRY	1,227.46	-
	SCINTILLOMETRY	345.50	-
	SP	258.25	-
	RESISTIVITY	49.00	-
	IP	8.70	-
	TURAN	21.70	-
	SLINGRAN	282.89	-
	VLF	209.02	-
ILMENITE PROSPECTING	SCINTILLOMETRY	85.00	10.54
URANIUM PROSPECTING	SCINTILLOMETRY	21,028.00	147,000.00
APATITE PROSPECTING	SCINTILLOMETRY	32.00	-

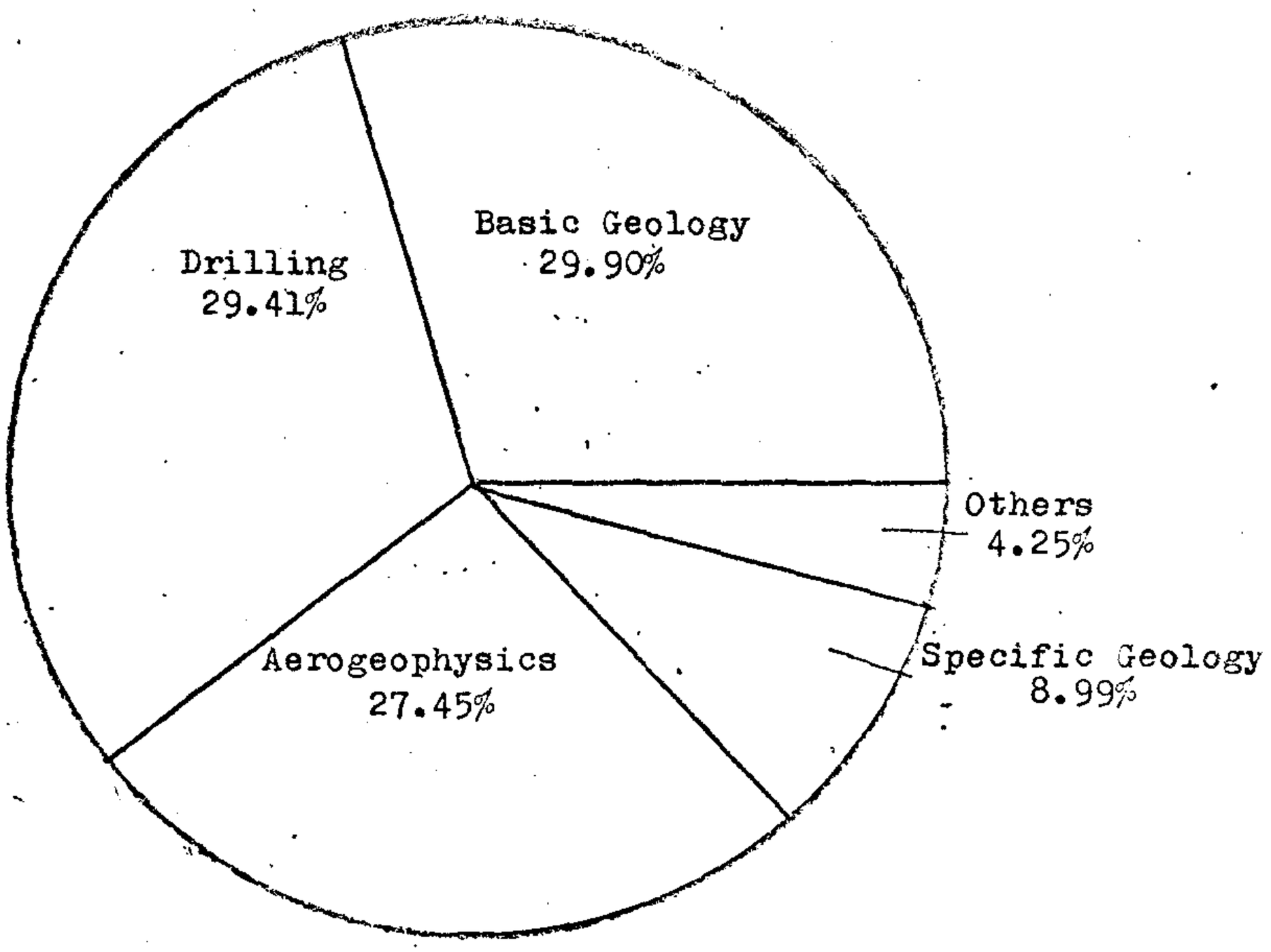
TABLE 3

CPRM

INVESTMENT ACCORDING TO TYPE OF SERVICE

(1970 - 1974)

SERVICE	INVESTMENT (US$)	%
BASIC GEOLOGY	18,300,000	29.90
DRILLING	18,000,000	29.41
AEROGEOPHYSICS	16,800,000	27.45
SPECIFIC GEOLOGY	5,500,000	8.99
OTHERS	2,600,000	4.25
TOTAIS	61,200,000	100.00



Graph 1

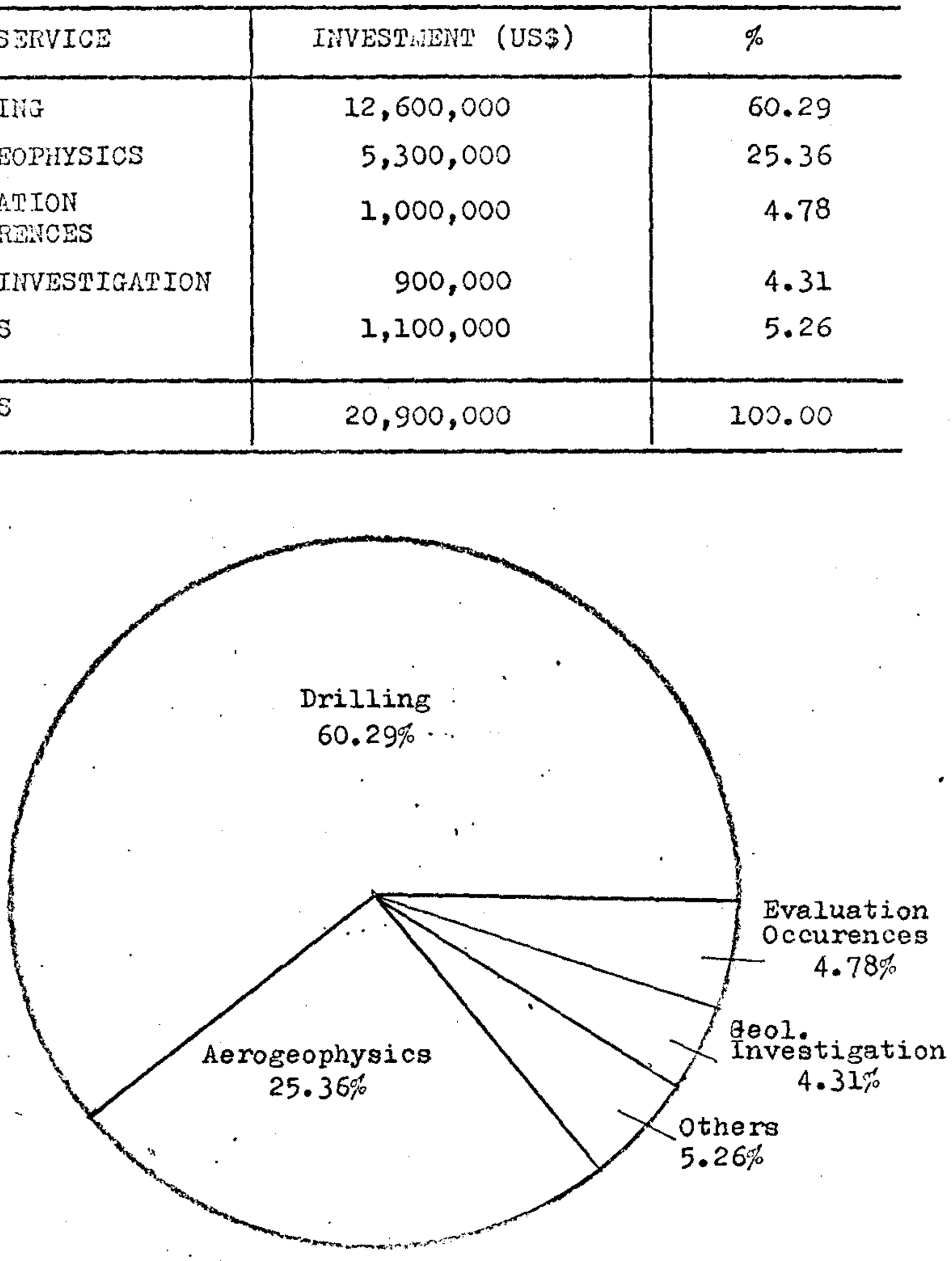
CPRM

INVESTMENT ACCORDING TO TYPE OF SERVICE

NATIONAL COMMISSION OF NUCLEAR ENERGY

(1970 - 1974)

SERVICE	INVESTMENT (US$)	%
DRILLING	12,600,000	60.29
AEROGEOPHYSICS	5,300,000	25.36
EVALUATION OCCURENCES	1,000,000	4.78
GEOL. INVESTIGATION	900,000	4.31
OTHERS	1,100,000	5.26
TOTAIS	20,900,000	100.00



Graph 2

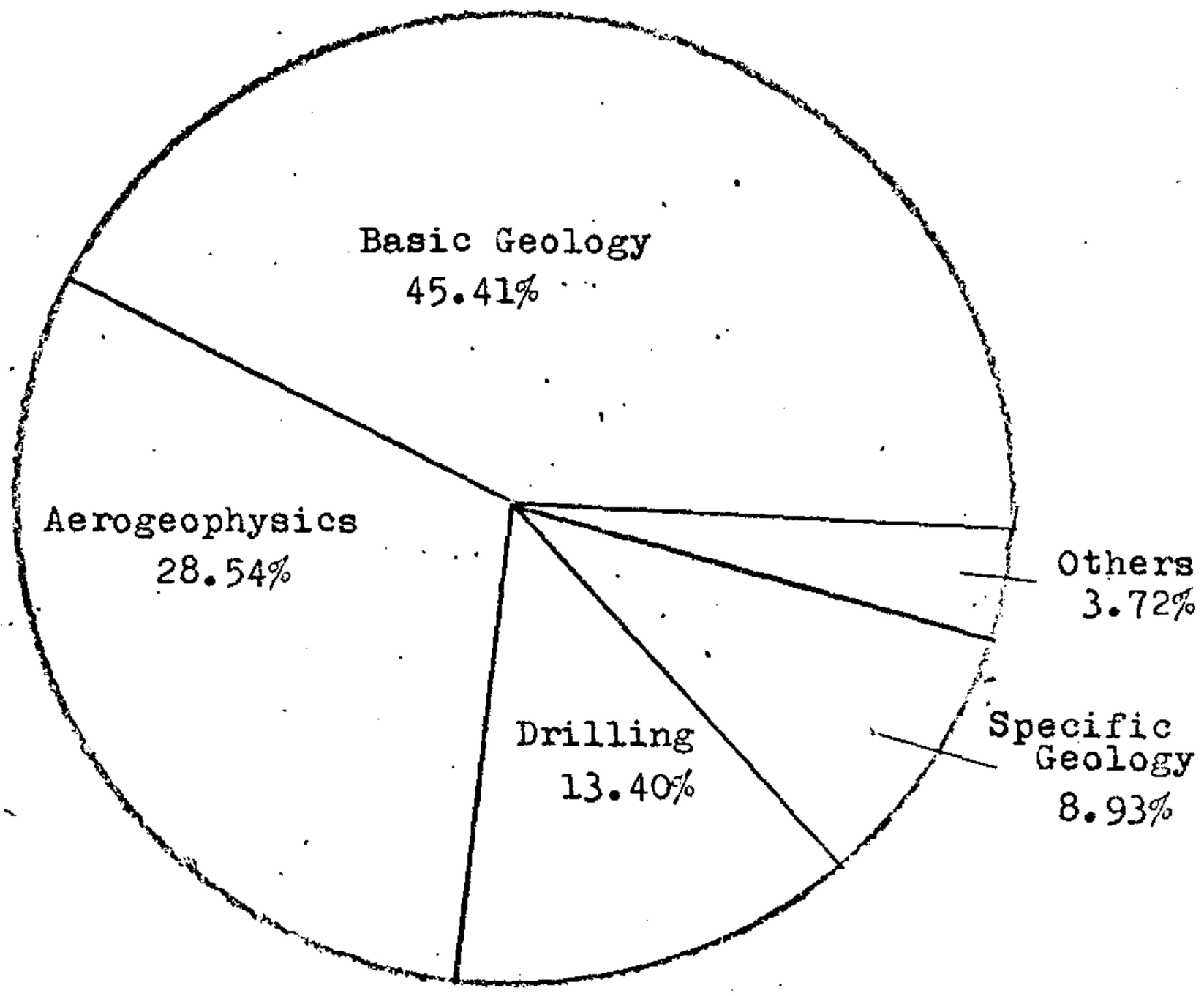
CPRM

INVESTMENT ACCORDING TO TYPE OF SERVICE

NATIONAL DEPARTMENT OF MINERAL PRODUCTION

.(1970 - 1974)

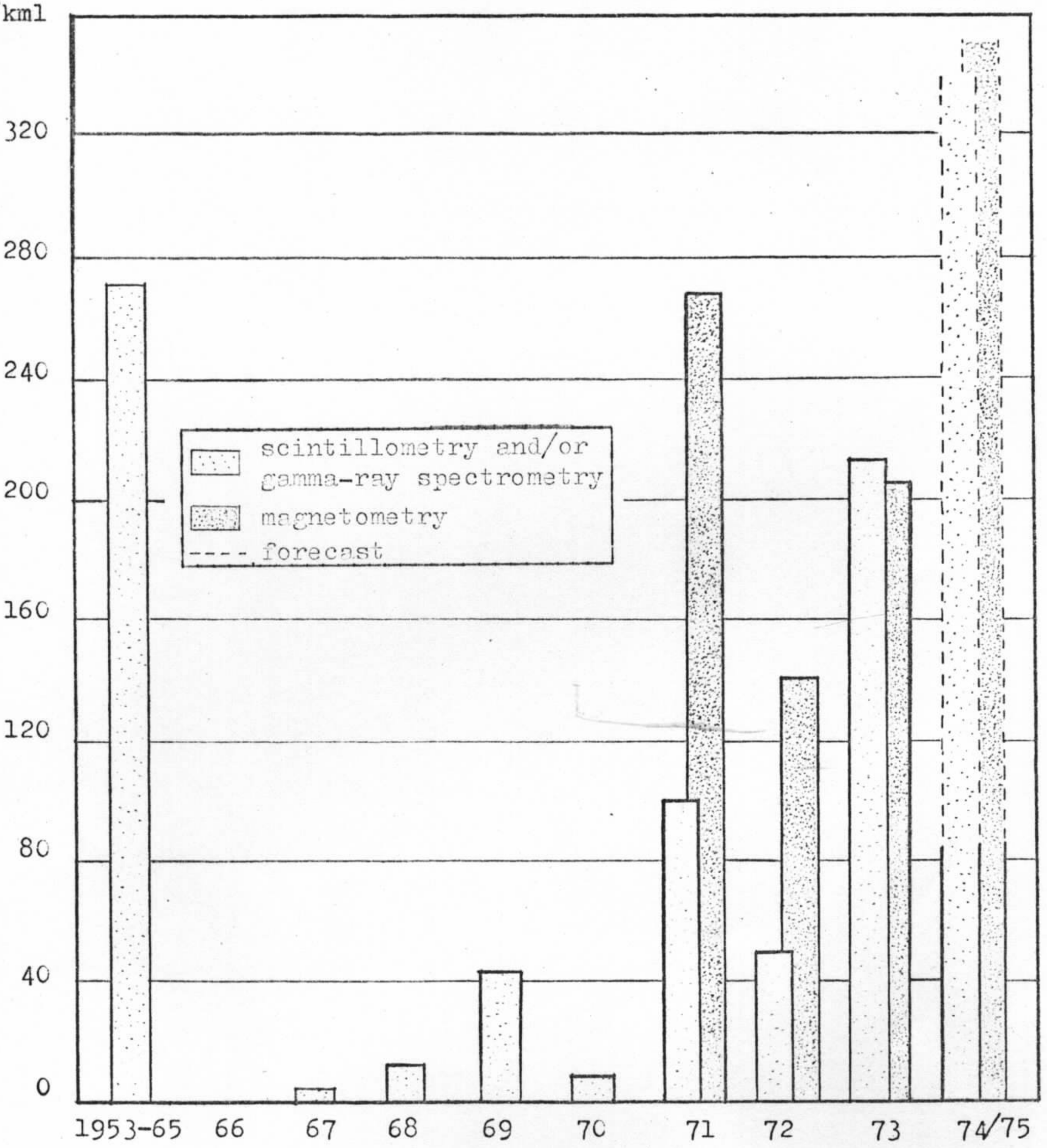
SERVICE	INVESTMENT (US$)	%
BASIC GEOLOGY	18,300,000	45.41
AEROGEOPHYSICS	11,500,000	28.54
DRILLING	5,400,000	13.40
SPECIFIC GEOLOGY	3,600,000	8.93
OTHERS	1,500,000	3.72
TOTAIS	40,300,000	100.00



Graph 3

CPRM

AEROGEOPHYSICAL SURVEYS



SOURCE: C.N.E.N. (1962/69)
C.P.R.M. (1970/74)

GRAPH 4

Companhia de Pesquisa de Recursos Minerais
-CPRM-

MAP OF BRAZIL

SCALE
0 100 200 300 400 500 km

AEROGEOPHYSICAL PROJECTS
(1971 – 1974)

1 - ACARAÚ
2 - A. GARÇAS
3 - BODOQUENA
4 - CAMAQUÃ
5 - CGBA (MG)
6 - CGBA (GO)
7 - CGBCA
8 - DIAMANTINA
9 - ESP. SETENTRIONAL
10 - FURNAS
11 - FRANCA
12 - IPORÁ
13 - ITABERABA-BELMONTE
14 - ITIÚBA
15 - PARÚ-RIO NEGRO
16 - PARNAMIRIM
17 - P. GROSSA-CRICIÚMA
18 - Q. FERRÍFERO
19 - RIO DO SANGUE
20 - RIO GUAPORÉ
21 - RIO MADEIRA
22 - RORÃIMA
23 - SERIDÓ
24 - SERRA DA MESA
25 - S. MAR SUL
26 - SUL PARÁ
27 - XINGÚ-ARAGUAIA

— 0 —

MB – 28