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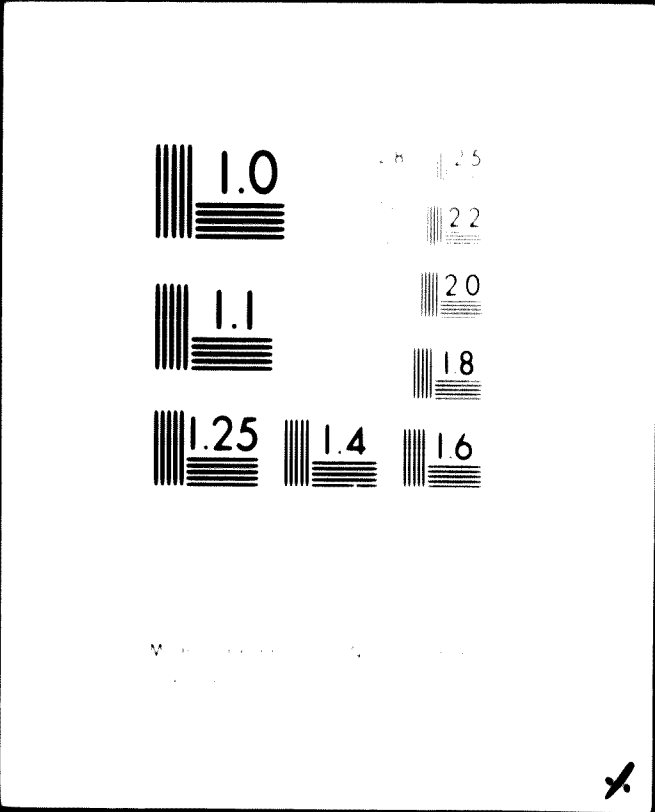
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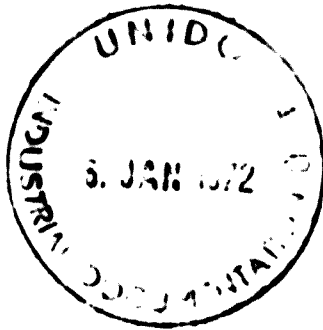
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Report of the mission to the USSR
to obtain information on certain
special technologies of non-ferrous
metallurgy of interest to developing
countries and to discuss details of
supporting activities planned for
1970 and 1971 in the USSR.

(31.8. - 6.9.69)

22 September 1969

L.C. Corrêa da Silva
E.T. Balazs

1. Introduction

The present report covers the mission of Messrs. L.C. Corrêa da Silva and E.T. Balazs to the USSR, which took place between 31 August and 6 September. The schedule of the mission is indicated in Annex I.

During the meetings and visits a large number of technical and administrative personnel of the highest calibre co-operated with the mission. In Annex II these persons are listed.

It is to be noted that the counterpart preparation of the mission's work was excellent and that the meetings and one plant visit were organized in such manner that a great deal of information and opinions were collected expeditiously. The co-operation of the State Committee for Science and Technology and especially of the Ministry of Non-Ferrous Metallurgy was complete and efficient. Total willingness to co-operate with UNIDO in the projects and technological areas discussed was expressed. Answers to all questions posed by the UNIDO staff members were given immediately and without restriction.

2. Objectives of the mission

The objectives of the mission included:

(a) gathering first hand information on certain technologies developed in the USSR in the field of non-ferrous metallurgy, of interest to the developing nations; (b) direct discussions with the agencies and technologists concerned, regarding the possibilities and specific details for transfer of such technology and "know how" to the developing nations through UNIDO; (c) discuss other questions of interest to ITD and to the Industrial Sector Development Section, at the request of the Director of the Division and of the Chief of the Section concerned.

More specifically, the objectives were the following:

(a) Status of USSR technology on the topics listed below, with discussion of the possibility, in principle, of its transfer to developing countries.

(i) - Processing of heavy black sands and ilmenitic ores to TiO_2 rich products (of potential interest to: Brazil, Ceylon, India, Malaysia, Senegal, Tanzania, United Arab Republic and possibly other countries). A number of UNIDO technical assistance projects have been completed, while others are still being implemented: Heavy Mineral Black Sands Project (Management expert, marketing economist and ore beneficiation expert) in the UAR; Heavy Mineral Black Sands Project (Economic geologist, chemical engineer and market analyst) in India; Metallurgical expert on TiO_2 production in Ceylon; Investigation of titaniferous iron ore from Tanzania).

(ii) - Utilization of nepheline-syenite ores for the production of aluminium (of potential interest to the UAR).

(iii) - Production of aluminium from alunite ores (of interest to Argentina, project ARG-058-B (SIS)).

(iv) - Production of aluminium alloys by direct processing and reduction of cyanite type ores (of interest to Brazil. Preliminary query received).

(v) - Production of aluminium from low grade bauxites (of interest to India).

(vi) - Special techniques used in copper production, particularly the operation of reverberatory furnaces for production of matte. (of interest to Turkey. Project TUR-021-B(ID)).

(vii) - Special techniques and "know how" related to the industrialization of mica. (of interest to India. Project IND-011-A, B(SIS)).

(viii) - Technology for industrialization of precious and semi-precious stones (of interest to Ceylon. Project CLY-021-A (SIS)).

(b) Discussion of specific information and details regarding action for increased use of USSR expertise and support (Rouble Contribution) for field and supporting activities programmed for the Metallurgical Industries Section in the area of non-ferrous metallurgy. The possible action contemplated comprised:

(i) - Use of experts from the USSR; availability, recruitment problems (for projects related to all of the items (i) to (viii) of previous section).

(ii) - Undertaking pilot-scale tests of certain ore samples from developing countries in USSR installations, to ascertain the practicability of their industrial and economic utilization (of special interest for items (i), (ii), (iii) and (v) of previous section).

(iii) - Preparation of feasibility studies eventually requested and relating to cases (i), (ii), (iii) and (iv) of the previous section.

(iv) - preparation of special reports reviewing available technology related to equipment, processes and materials for production of certain non-ferrous metals.

(v) - Co-operation in the organization of two supporting activities programmed for 1970 and 1971, to take place in the USSR: Seminar on Copper Production and Group Study Tour of Copper Plants in the USSR (1970); Seminar on Complex Titanium-Iron Ore Processing (1971).

(vi) - Facilitating opportunities for training in the USSR of recipients of UNIDO fellowships, in the area of non-ferrous metal production, specially in the technologies already listed in Section 1.

(c) Discussion of other topics of interest to ITD, as per instructions received from the Division Director and request received from the Industrial Sector Development Section:

(i) - Possibility of a visit of Mr. V.M. Kostjin, Deputy Minister of Non-Ferrous Metallurgy of the USSR, to UNIDO, in Vienna.

(ii) - Possibility of having the Institute of Information on Non-Ferrous Metallurgy (Tsvetmetinformacia) to keep up to date and expanding the Report already prepared by them on "Aluminium, copper, lead, zinc and tin industries in developing countries", June 1969.

(iii) - Cause of delay in delivery of the Report on "Iron and steel industry of developing countries", prepared by the Institute of Information on Iron and Steel Metallurgy (Chermetinformacia) and possibility of its future up-dating.

3. Justification of the mission

The Metallurgical Industries Section has now a number of projects dealing with problems of non-ferrous metallurgy (see previous Section) for which technical solutions developed in the USSR would seem to be particularly applicable, especially if combined with technology developed elsewhere. A good number of other similar projects, for other countries, could probably be generated. However, detailed and specific information on USSR industrial use of the techniques was lacking.

In particular, and as an example, the staff of the Metallurgical Industries Section has recently suggested that the final and best solution for utilization of the complex titanium-iron ores usually known as "heavy black sands" might lead to the intensive and profitable exploitation of the deposits of Brazil, Ceylon, India, Malaysia, Senegal and the United Arab Republic. Other countries might be added to this list. However, various details and questions regarding the techniques developed in the USSR remained obscure and the real possibilities of their utilization by developing countries had to be gauged by personal contacts and visits.

Other questions such as the recruitment of USSR experts for certain posts and the organization of planned supporting activities in the USSR (see previous section) had to be discussed personally.

4. Results of the mission

(a) Status of USSR technology for the solution of certain particular problems of non-ferrous metals production

(i) - Processing of heavy black sands and ilmenitic ores to TiO_2 or TiO_2 rich products:

- The technology for production of TiO_2 rich slags has reached the highest degree of development in the USSR. Information gathered during our discussions and during our visit to a plant in Zaporozhie show conclusively that from ilmenitic concentrates a slag containing nearly 90 per cent TiO_2 can be normally produced in relatively simple electric reduction furnaces of a small capacity. The apparent simplicity of the process and equipment, which is, of course, the result of many years of development, make the technology attractive to developing countries rich in titaniferous ores. The product of this operation is a readily marketable raw material for production of TiO_2 pigment by the modern process of chlorination in local installations or for export. Extensive information was obtained and will be included in a separate, strictly technical and detailed report. The Metallurgical Industries Section feels that the technology available in the USSR is of definite practical and immediate interest to the developing countries already mentioned in this connection.

(ii) - Utilization of nepheline-syenite ores for the production of aluminium:

- This problem has been solved successfully in the Soviet Union for the ores available there, both from the technical and economical points of view, large installations existing for the production of alumina, cement and soda. The question whether such technology is applicable in other countries will require detailed study of the ores available locally.

(iii) - Production of aluminium from alunite ores:

- The problem has also been solved technically in the Soviet Union, a plant of appreciable size for the production of alumina existing on the basis of alunite as a raw material. Here again, the transfer of this technology to developing countries will depend on detailed study of local ores and conditions.

(iv) - Production of aluminium alloys by direct processing and reduction of cyanite type ores:

- This problem is also technically and economically solved in the Soviet Union and aluminium-silicon alloys are regularly produced from various raw materials. The transfer of technology will depend on specific examinations of local conditions in the interested developing countries.

(v) - Production of aluminium from low grade bauxites:

- This problem has been solved in the USSR through direct metallurgical processing of low grade bauxites of compositions typical of the Soviet Union, industrial installations existing. Transfer of technology also possible in principle, depending on the specific consideration of local conditions.

(vi) - Special techniques used in copper production:

- There will be no problem in supplying "know how" on copper production technology since the USSR has a large production of this metal based on a variety of ores, including some very complex ones.

(vii) - Special techniques and "knowhow" related to the industrialization of mica:

- The USSR has the technology required, but it falls outside the sphere of action of the Ministry of Non-Ferrous Metallurgy. The latter has, however, expressed willingness to route the problem to the appropriate agencies.

(viii) - Technology for utilization of precious and semi-precious stones:

- Technology available. Requests for technical assistance can be met without difficulty and the Ministry of Non-Ferrous Metallurgy also expressed willingness to help in this matter.

(b) Discussion of specific action for increased use of USSR expertise in non-ferrous metallurgy

(i) Recruitment of USSR experts:

- A large number of highly qualified experts exist in practically all fields mentioned, but these experts are frequently engaged in activities from which they may not be able to disconnect themselves for long stretches abroad. Another difficulty may be, in many cases, the question of language, since most Soviet experts, although understanding and reading English and/or other foreign languages, do not usually have the practice to speak them. Interpreters might be necessary to make full use of certain high level experts. So far as the Ministry of Non-Ferrous Metallurgy is concerned, great willingness was expressed in co-operating in this area and direct contacts between UNIDO and the Ministry through the Director of its Foreign Relations Division, Mr. V.P. Rakov. It was suggested that when the need for an expert presents itself, we communicate it directly to Mr. Rakov, with a copy (or original) being simultaneously routed through the USSR Permanent Mission to UNIDO in Vienna.

(ii) Undertaking of pilot scale tests of certain ore samples for developing countries in USSR installations, especially of titanium-rich ores:

- This possibility was discussed at length both in Moscow and at the Dnepr Titanium Magnesium plant in Zaporoshie. Detailed information on the requisites, conditions and technological implications of such tests was obtained, especially for the case of complex titanium-iron ores "heavy black sands". In this case it was estimated that a sample of 1000 tons of concentrate would be ideal to allow thorough pilot scale testing under industrial conditions in the small furnaces available in Zaporoshie which are similar to the ones that could be eventually recommended to developing countries. The cost of the complete testing, including final detailed report, was estimated at some 150,000 Roubles, this amount including all costs from port to plant to port in the Soviet Union, the products obtained being returned to the interested developing country. These products

would be: TiO_2 rich slag (85 - 89 per cent TiO_2), pig iron, with possibly smaller amounts of titanium tetrachloride and TiO_2 pigment. The latter feature (return of products of the tests to the country interested) is particularly interesting since it would allow eventual additional processing into more elaborate products like titanium tetrachloride or TiO_2 pigment. Preliminary to pilot scale tests, laboratory scale experimentation could be carried out on samples of 20 kgs and/or 200 kgs approximately. It should be emphasized that the experimental work just described (pilot plant scale tests of TiO_2 -bearing materials) is of a very specialized nature and the opportunity now opened is of specific practical interest to the developing countries having TiO_2 rich ores.

(iii) Preparation of feasibility studies:

- During the meetings we received the assurances that feasibility studies can be undertaken by USSR organizations for installation of pilot or industrial scale plants for the production of TiO_2 or TiO_2 rich products, aluminium from nepheline-syenite ores and from alunite ores, aluminium alloys by direct reduction of cyanite ores. However, the industrial use of the process developed in the Soviet Union may depend on licensing. This matter might be the subject of negotiation between the interested country and the USSR. Here again, it must be pointed out that the "know how" involved in the preparation of such feasibility studies is of a very special nature and, in certain cases, it is only available in the USSR.

(iv) Preparation of special reports reviewing branches of non-ferrous metals technology:

- During the contacts no great enthusiasm was shown by the USSR officials and experts for this sort of work. They seem to feel that reports should be geared to specific problems and conditions of given developing countries. There is some justification for this point of view, but on the other hand, we feel that informative synthesis of essential technical facts and experiences relating to the metallurgy of the common non-ferrous metals would be of use

to developing countries. We feel that this matter can be pursued through the Institute for Information on Non-Ferrous Metallurgy (Tsvetmetinformacia).

(v) Co-operation in the organization of supporting activities programme for 1970 and 1971:

- a. Our updated programme for 1970 includes a Seminar on Copper production and Group Study Tour of Copper Plants in the USSR. ^{1/} The co-operation of USSR organizations and experts for the implementation of this supporting activity was discussed and received full support. The USSR experts recommended the restriction of the scope of the Seminar to the metallurgy of copper only and we agreed with this suggestion. It was also agreed that some five papers will be prepared by Soviet experts on various aspects of the metallurgy of copper; the titles and authors will be proposed to UNIDO in the near future. At our request, the USSR experts will also suggest a programme of technical topics and of plants to be visited. Other details regarding the number of participants (30 in all, from outside the USSR) were also established. This supporting activity will be partly financed from the Rouble Contribution. It is to be noted that this supporting activity has received priority in UNIDO for support from UNDP funds. Continued contact will be maintained with the USSR authorities from now on for the preparation of this activity. The officer in charge will be Mr. Christo Popov.

- b. Seminar on Complex Titanium-Iron Ore Processing (1971)
The co-operation of USSR organizations and experts with this supporting activity to take place in the USSR was discussed, full support being promised for the preparation of the Seminar and papers to be presented. A suggested programme of topics and visits was also promised by the Soviet experts and should be forthcoming. Various details regarding the implementation of this planned activity were discussed.

^{1/} The scope of the Seminar originally included copper, nickel and cobalt.

(vi) Opportunities for training in the USSR in non-ferrous metals production.

- There was no difficulty in getting the agreement, in principle, of the USSR authorities to facilitate training of UNIDO fellows in particular fields of non-ferrous metallurgy.

(c) Other topics discussed

(i) Visit of Mr. V.N. Kostjin, Deputy Minister of Non-Ferrous Metallurgy of the USSR to UNIDO in Vienna:

- Consultation on this matter was carried under the instruction of Mr. N.K. Grigoriev. Although Mr. Kostjin was unavailable for direct consultation, having had to leave on an urgent mission abroad, the Ministry authorities expressed the opinion that Mr. Kostjin would be glad to receive a formal invitation.

(ii) Up-dating and expansion of the report on non-ferrous metals industries in developing countries prepared by the Tavetmetinformacia:

- The representatives of the Institute for Information on Non-Ferrous Metallurgy expressed the willingness of the Institute to undertake annual up-dating and eventual expansion of the scope to include other metals than already studied. The whole matter will, of course, depend on a contract being signed with UNIDO. The preparation of a "pro forma" contract was promised by them.

(iii) Delay in delivery of the report on the iron and steel industry of developing countries:

- This report, prepared by the Institute of Information on Iron and Steel Metallurgy (Chermetinformacia) has not yet been delivered. At the request of Mr. J. Fath, Industrial Sector Development Section, a meeting was held in the Ministry of Ferrous Metallurgy. We were informed that the report is finished but was under review by Mr. Kuleshov, Director of the Institute. It should be cleared in a couple of weeks and forwarded through channels to UNIDO. Our request that a copy be made available immediately and non-officially for perusal in UNIDO could not be met.

5. Recommendations regarding action by UNIDO

(a) To approach the Government of the UAR to generate requests for the following:

- (i) Pilot scale test of 1000 tons of ilmenite concentrates in USSR installations (Rouble Contribution)
- (ii) Feasibility study of a pilot scale demonstration plant for production of titanium-rich slag and pig iron. (Special Fund and/or Rouble Contribution)
- (iii) Study of the techno-economic feasibility of utilization of UAR nepheline-sienite ores for the production of alumina and by-products.

(b) To approach the Government of Tanzania to generate the following requests:

- (i) Laboratory-scale investigation of Tanzanian iron-titanium ores and concentrates in the USSR (SIS or TA)
- (ii) Pre-feasibility study of an iron-titanium ore dressing and processing plant (SIS)

(c) To approach the Government of Senegal to generate the following requests:

- (i) Pre-feasibility study of an ore dressing and processing plant for the local titanium-iron ores (heavy black sands)(SIS)
- (ii) Laboratory-scale investigation of ore samples of the Senegal titanium-iron ores in the USSR (SIS or TA)

(d) To approach the Government of India to generate the following requests:

- (i) Laboratory-scale investigation of Indian ore and concentrate samples (of heavy black sands) in the USSR (SIS)
- (ii) A study of the techno-economic feasibility of the utilization of Indian low grade bauxites for the production of alumina.

(e) To approach the Government of Ceylon to generate the following requests:

- (i) Special Fund pre-project mission and feasibility study of a pilot scale demonstration installation for complete processing of heavy black sands to TiO_2 rich materials and pig iron (Special Fund or Rouble Contribution)

(ii) Laboratory scale investigation in the USSR of the suitability of Ceylon titanium-iron ores and concentrates for production of TiO_2 pigment or TiO_2 rich products and pig iron (SIS or TA)

(iii) Special Fund project for installation of a pilot scale demonstration plant for complete processing of heavy black sands to TiO_2 rich materials, pig iron and by-products (After conclusion of items 1 and 2 above).

(f) To approach the Government of Malaysia to generate the following requests:

(i) Study of the techno-economic feasibility of exploitation and industrialization of Malaysian titanium-iron ores.

(g) To approach the Government of Brazil to generate the following requests:

(i) Study of the techno-economic feasibility of local production of TiO_2 rich slag and pig iron by electrothermal reduction (SIS)

(ii) Feasibility study of a pilot scale demonstration plant for production of aluminium-silicon alloys by direct reduction of cyanite type ores (SIS or TA)

(h) A Special Fund Project may be generated, consisting of:

(i) Pre-project survey mission on possibilities of processing heavy black sands and titaniferous iron ore deposits in developing countries to valuable titanium and iron-bearing products, with consideration of possible by-products. The project should consist of three parts, one for Africa, one for Asia and one for Latin America, and it may be processed in conjunction with ECA, ECAFE and ECLA.

(ii) Special Fund project, following previous pre-project survey mission, to include feasibility studies of plant construction

in appropriate locations, in selected countries or regions. Such studies should include detailed surveys of raw materials and market as well as detailed recommendations regarding action to exploit, dress and process titaniferous ores on a sound techno-economic basis. It should also include a training component, for specialization of engineers of developing countries in the techniques involved in those operations.

(i) Request from the USSR authorities the experts, "know how" and other facilities needed for the projects mentioned above, when pertinent, and for other projects already in implementation, such as: TUR-021-B (1D) Expert in Copper Production; IND-011-A (SIS) Mica processing industry expert; IND -011-B (SIS) Mica marketing expert; and CEY-021-A (SIS) Development of the Gem Industry.

(j) Request the Institute for Information on Non-Ferrous Metallurgy to prepare special technical reports covering the following topics:

- Ore dressing of heavy black sands and of other titaniferous ores
- Production of TiO_2 rich slags and of pig iron by direct electrothermal reduction of titaniferous ores
- Production of $TiCl_4$ and pigment grade TiO_2
- Production of alumina from low grade bauxites, nepheline-sienite and alunite
- Production of aluminium-silicon alloys by direct reduction of the appropriate ores
- New developments in the metallurgy of copper

The details of the topics and of contracts to be signed must be discussed.

(k) Request the Institute for Information on Non-Ferrous Metallurgy to up-date annually their Report "Aluminium, Copper, Lead, Tin and Zinc Industries in Developing Countries", and to expand the scope of the same to include the metallurgy of nickel and the production of TiO_2 rich products. Contract to be discussed by the Industrial Sector Development Section.

(l) Send to the Ministry of Non-Ferrous Metals, through appropriate channels, the preliminary pertinent data on the Seminar on Copper Metallurgy and Group Study Tour of Copper Plants in the USSR (1970), including estimates of the local support desired from the USSR organizations and experts.

(m) Send to the Ministry of Non-Ferrous Metals, through appropriate channels, the preliminary pertinent data on the Seminar on Complex Titanium-Iron Ore Processing (1971), including estimates of the local support desired from the USSR organizations and experts.

ANNEX I

Schedule of the Mission

31/8/1969,	Sunday	Departure from Vienna to Moscow at 2 p.m., by plane. Arrival in Moscow
1/9/1969,	Monday	Meeting and discussions in the Ministry of Non-Ferrous Metallurgy, Moscow, at 10 a.m. and 2 p.m.
2/9/1969,	Tuesday	Meeting and discussions in the Ministry of Non-Ferrous Metallurgy, Moscow, at 10 a.m. and 2 p.m.
3/9/1969,	Wednesday	Meeting and discussions in the Ministry of Iron and Steel Metallurgy, Moscow, at 10 a.m. Visit to the USSR Permanent Industrial Exhibition on Non-Ferrous Metals Metallurgy at 3 p.m.
4/9/1969,	Thursday	Departure from Moscow to Zaporoshie at 2 p.m., by plane. Arrival in Zaporoshie
5/9/1969,	Friday	Meeting and discussions at the offices and visit to the thermal reduction shop of the "Dnepr" Titanium-Magnesium Plant. Departure from Zaporoshie to Moscow at 5 p.m., by plane. Arrival in Moscow.
6/9/1969,	Saturday	Departure from Moscow at 11 a.m., by plane. Arrival in Vienna.

ANNEX II

List of persons with whom discussions were held during the course of the mission

1. Ministry of Non-Ferrous Metallurgy, Moscow

Mr. V. Rakov	Director of Division of External Relations
Mr. L. Bobkov	Director of Division of Aluminium Production
Mr. N. Shaburov	Deputy Director of Division of External Relations
Mr. V. Borodai	Director of Division of Titanium and Rare Metals Production
Mr. A. Gribov	Deputy Director of Titanium and Rare Metals Production Division
Mr. S. Mareynis	Deputy Director of Titanium and Rare Metals Production Division
Mr. O. Bogoroditzki	Officer of Section of Economics, Division of External Relations
Mr. N. Jakushin	Representative of the USSR State Committee of Science and Technology
Mr. V. Mikhajlov	Deputy Director of Institute "Tsvetmetinformacia"
Mr. N. Umanskaya	Chief of Department of Economics of Institute "Tsvetmetinformacia"
Mr. V. Matvejev	Senior expert of the USSR State Committee of Science and Technology

2. Dnpr Titanium-Magnesium Plant, Zaporoshie

Mr. V. Ustinov	Director of the plant
Mr. A. Petrunko	Chief Engineer of the plant
Mr. I. Shachrai	Manager of the thermal reduction shop
Mr. E. Novsjesov	Deputy Manager of the experimental shop
Mr. R. Ogniov	Director of Central Titanium Research Institute, Zaporoshie
Mr. S. Denisov	Chief of Titanium-slag Laboratory in the Central Titanium Research Institute

3. Ministry of Iron and Steel Metallurgy, Moscow

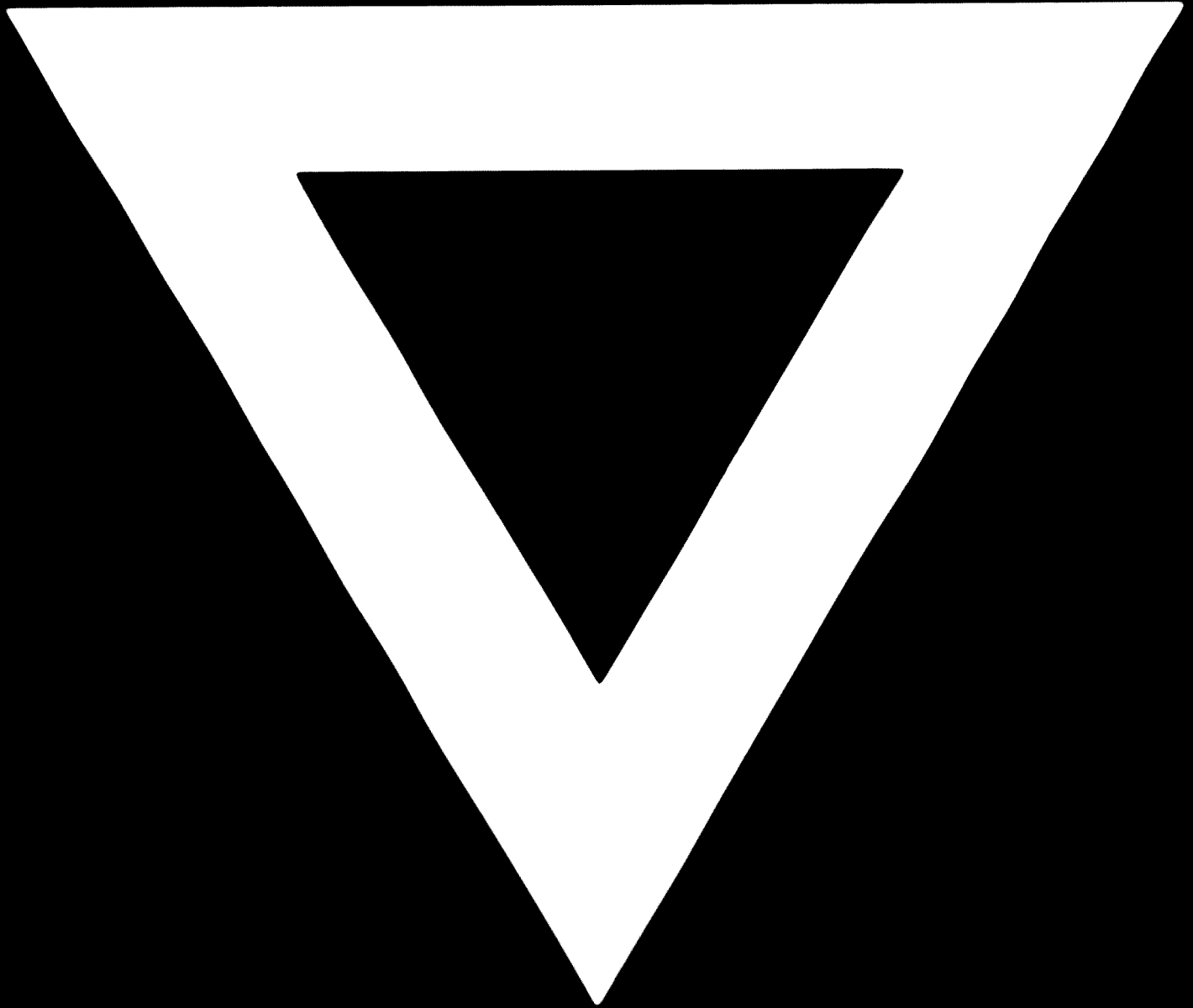
Mr. A. Dello

Chief of Department of Division
of External Relations

Mr. P. Malinin

Deputy Director of Division of
External Relations

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