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# ASSISTANCE TO TSKB (INDUSTRIAL DEVELOPMENT BANK OF TURKEY)

DP/TUR/76/018

TURKEY

Technical report:
DEVELOPMENT OF THE CHEMICAL INDUSTRY

Prepared for the Government of Turkey by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

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United Nations Development Programme

ASSISTANCE TO TSKB

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# Technical report: Development of the chemical industry

Prepared for the Government of Turkey by the
United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Edward H. Zawada, expert in chemical industry planning

United Nations Industrial Development Organization
Vienna, 1977

## Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise stated.

The monetary unit in Turkey is the Turkish lira (LT). During the period covered by the report, the value of the LT in relation to the United States dollar was $US 1 = LT 16.90.

References to "tons" are to metric tons, unless otherwise specified.

The following forms have been used in tables:

Three dots (...) indicate that data are not available or are not separately reported;

A dash (-) indicates that the amount is nil or negligible;

A blank indicates that the item is not applicable.

The following abbreviations of organizations are used in this document:

| | |
|---|---|
| MTA | Mineral Research and Exploration Institute of Turkey |
| TSKB | Türkiye Sinaî Kalkinma Bankasi A. Ş. (Industrial Development Bank of Turkey) |

The following technical abbreviations are used in this document:

| | |
|---|---|
| MW | megawatt |
| t/a | ton per annum |
| t/d | ton per day |
| CBR | cis-butadiene rubber |
| DAP | diammonium phosphate |
| GNP | gross national product |
| NPK | nitrogen-phosphorus-potassium (fertilizer) |
| PVC | polyvinyl chloride |
| SBR | styrene-butadiene rubber |
| TDI | toluylene diisocyanate |

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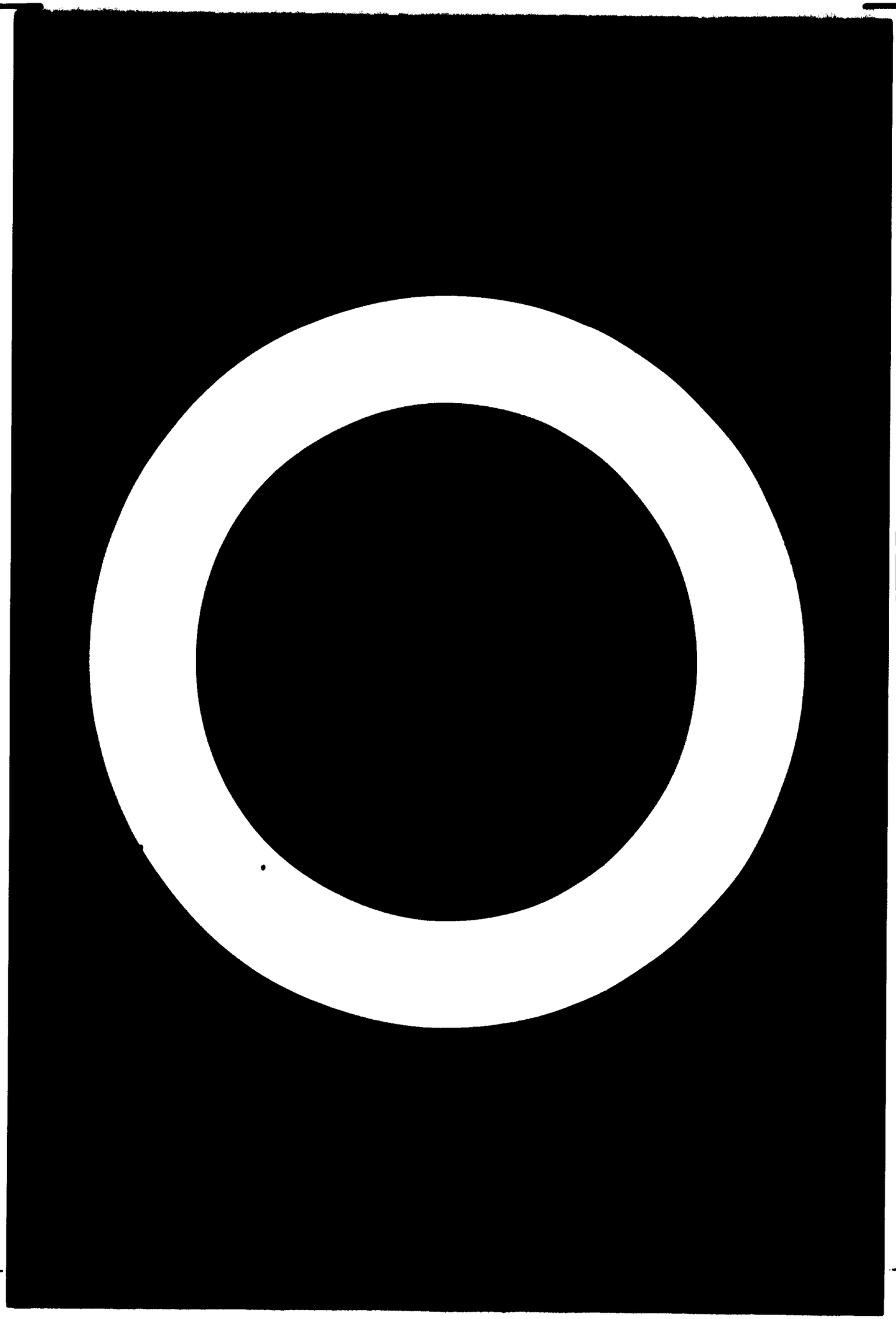
## ABSTRACT

As part of the United Nations Development Programme (UNDP) project DP/TUR/76/013, "Assistance to TSKB (Industrial Development Bank of Turkey)" (Türkiye Sinaî Kalkinma Bankasi A. Ş.), the United Nations Industrial Development Organization (UNIDO), as executing agency for the project, sent an expert in chemical industry planning to Turkey for one month (7 December 1976 to 3 January 1977) to assist in drawing up a general plan for investment in and development of the chemical industry in Turkey. The expert found that the potential for development of an industry producing a wide range of chemical products - fertilizers, heavy chemicals, dyes, pesticides, detergents, paints, elastomers and pharmaceuticals - is high. As part of the general plan to achieve this potential, the expert suggests making detailed surveys of the sectors just mentioned with special attention given to choosing optimum plant size, increasing export possibilities, integrating the industry in the technological and spatial senses, establishing engineering facilities and investigating certain short-term investment opportunities. An effort should be made to complete the sectoral surveys by mid-1977, with further expert assistance.



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## INTRODUCTION

In the industrial development of Turkey, heavy chemicals and machine building have hitherto been neglected but are intended to be developed rapidly in the Fourth Five Year Plan (1978-1983). Therefore, the Government, in July 1976, requested assistance from the United Nations Development Programme (UNDP) in the form of experts who would work with personnel of the Industrial Development Bank of Turkey (Türkiye Sinaî Kalkinma Bankasi A.Ş. (TSKB)) and assist them in studying those sectors to identify investment opportunities. TSKB is a private bank that finances projects within various sectors of industry.

Subsequently, UNDP project DP/TUR/76/013 "Assistance to TSKB (Industrial Development Bank of Turkey)" was established, with the United Nations Industrial Development Organization (UNIDO) as executing agency. The project document, which was signed on behalf of UNDP on 5 November 1976, committed a total of $7,900 (UNDP, $4,391; Government, $3,509) for the retention of two experts, each for one month, one in capital goods manufacturing and the other in chemical industry planning. This report is the final report of the latter expert, who was in Turkey from 7 December 1976 to 3 January 1977.

In accordance with his job description (annex I), the expert first investigated the present situation of the chemical industry in Turkey, i.e., production, imports and exports, actual investments, raw material availability etc. (see chapters I and II). These chemical plants were visited:

| | |
|---|---|
| Koruma Tarım İlâçları A.Ş. | (chlorine, pesticides) |
| Gübre Fabrikaları A.Ş. | (phosphoric acid, trisodium phosphate) |
| Sifaş Sentetik İplik Fabrikaları A.Ş. | (nylon 6, nylon 66, polyester fibre) |
| Etibank Bandırma Boraks ve Asit Sülfürik Fabrikaları | (borax, boric acid, perborate) |
| Fako | (pharmaceuticals) |
| Squibb | (pharmaceuticals) |

The expert's main tasks were the elaboration of the methodological framework for planning of the chemical industry in Turkey (chapter III) and the drawing up of a general plan for development and investments (chapter IV).

The report concludes with a list of recommendations (chapter V), the central one being that detailed studies on the indicated sectors of the chemical industry be completed by mid-1977.

During the mission, Ahmet Arzan, a chemical engineer, assisted the expert as the TSKB counterpart.

## I. THE PRESENT SITUATION OF THE CHEMICAL INDUSTRY IN TURKEY

Chemical production in Turkey began as early as 1939, with the production of ammonium sulphate in the coke factory at Karabük (capacity 3,500 t/a). The development of a modern chemical industry did not begin to be significant until the 1960s, when new nitrogen and phosphorous fertilizer plants were established. Later, production of boron salts, dyestuffs, pharmaceuticals and insecticides was established. With the recent start-up of the petrochemical complex at Yarımca, the production of polymers and certain industrial chemicals has been initiated. The production and production capacity of chemicals in Turkey in 1975 is shown in annex II.

The chemical industry in Turkey is in both the public and the private sectors, with the large investments (nitrogen fertilizers, oil refining and petrochemicals) being in the public sector and the small and medium-size ones in the private sector.

Current production of chemicals does not cover domestic demand. The import of chemical products in 1974 amounted to approximately LT 8 billion (about $600 million), 15% of total imports (see annex III). Exports are only just beginning ($20 million) and amount to only 1.4% of total exports.

### Fertilizer industry

As annex II shows, fertilizers are the most important products of the Turkish chemical industry. Fertilizer production is the sector in which the greatest investment activity takes place. Turkey has 24.6 million hectares of cultivated area, of which only about 6 million are treated chemically. About 1 million tons of fertilizers were imported in 1975, as well as all the phosphates and a portion of the ammonia and sulphuric acid used.

The state-owned firm Azot Sanayii T.A.Ş. has factories at Kütahya, Elâzığ, Samsun and Gemlik and plans to set up a new one at Mersin:

Kütahya: 400 t/d of ammonia, ammonium sulphate and ammonium nitrate are produced. Further expansion of capacity is planned;

Elâzığ: Production of superphosphate was established in 1971;

Samsun: In 1972, production of sulphuric acid (700t/d), phosphoric acid (230 t/d), triple superphosphate (TSP) (700 t/d) and diammonium phosphate (DAP) (470 t/d) was started in 1972, and a new plant for phosphoric acid (340 t/d) and DAP (720 t/d) was started up in 1975;

Gemlik: A new ammonia plant (1,000 t/d) is under construction; a phosphoric acid plant (1,200 t/d) will also be built;

Mersin: The existing sulphuric acid plant produces 700 t/d sulphuric acid, 1,100 t/d nitric acid, 215 t/d phosphoric acid and 450 t/d DAP. The production of the plant is based on imported ammonia; however, by 1980 the new ammonia plant (900 t/d) will be finished.

Gübre Fabrikaları T.A.O. at Iskenderun and Yarımca produces sulphuric acid (400 t/d) and superphosphate. In 1980/81, production of phosphoric acid (500 t/d), DAP (600 t/d) and complex fertilizer will be initiated. A new sulphuric acid plant (1,500 t/d) was recently contracted.

A new fertilizer plant with a production of 960 t/d NPK is planned at Foça. A capacity of 600 t/d of sulphuric acid and 200 t/d of phosphoric acid is planned for a second stage. A new plant for 1,000 t/d of ammonia and 1,550 t/d of urea has been completed at the Ipraş Refinery near Izmit.

All phosphate raw material is imported. Exploitation of domestic deposits at Mardin is under discussion.

## Utilization of domestic mineral resources

The mineral potential of Turkey is just beginning to be utilized; only a small part of the gross national product (GNP) comes from the mining industry.

There are boron ore deposits that are being exploited; the run-of-the-mine production in 1975 was 650,000 t. Some of the ore is used to make borax, boric acid and perborates.

The run-of-the-mine produotion of chromium ore in 1975 was 625,000 t. This ore is exported after conoentration. The manufacture of dichromates is in the planning stage.

The production of mercury (304.5 t in 1973) is very important for salt electrolysis.

## Expansion of organic chemistry

Turkey has an annual production of about 5 million tons of bituminous coal and about 9 million tons of lignite. The annual production of crude oil is 3.4 million tons; another 10 million tons is imported.

The first state-owned petrochemical complex is Petkim at Yarımca, where, on the basis of an ethylene production of 60,000 t/a, polyethylene, PVC, polystyrene, dodecylbenzene and synthetic butadiene rubbers are produced. A caprolactam plant has just been completed there.

In early 1980, a new petrochemical complex will start up at Aliağa. The planned capacities are:

| | (thousand t/a) |
|---|---|
| Ethylene | 350 |
| Propylene | 140 |
| Benzene | 140 |
| Polyethylene | 150 |
| PVC | 100 |
| Polypropylene | 60 |
| Ethylene glycol | 70 |
| Terephthalic acid | 70 |

The main producer of synthetic fibres is SİFAŞ at Bursa. The production programme is nylon 6, 8,000 t/a; nylon 66, 2,000 t/a; polyester fibres, 5,000 t/a.

Tekstil Sanayii ve Ticaret has also started production of synthetic fibres at the rate of 2,650 t/a. AKSA produces 10,000 t/a acrylic fibres, to be expanded to 26,000 t/a. SASA in Adana intends to build a 60,000-t/a dimethyl terephthalate plant with expansion possibilities to 120,000 t/a.

Marmara Entegre Kimya Sanayii at Çanakkale plans to start production of formaldehyde (37%) at the rate of 30,000 t/a and urea-formaldehyde resins (42,000 t/a), and Çukurova Kimya A.Ş. will produce furfural (2,000 t/a) and acetic acid (1,200 t/a).

Near Istanbul, there are several pharmaceutical plants, which are mainly involved in formulation.

## Summary

The situation of the Turkish chemical industry can be summarized as follows:

(a) The technical level of the plants (some of them have been visited by the expert) is at the normal European standard;

(b) The capacities of the older plants are quite low or just average. Only the plants that have been recently built or are under construction have optimal capacity;

(c) There is a rather high dependence on imported raw materials and intermediates, and backward and forward integration of production is, with some exceptions, at a standstill;

(d) Environmental and pollution standards are not being maintained. All plants at the seaside are discharging wastes directly into the water;

(e) The qualifications of the personnel are at a satisfactory level;

(f) The domestic demand for chemicals exceeds the production capacity and is constantly increasing. That is why no significant efforts are being made to export chemical products;

(g) Turkey has all the necessary conditions for the further development of a wide-spectrum chemical industry.

## II. AVAILABILITY OF RAW MATERIALS FOR THE CHEMICAL INDUSTRY

Turkey has a significant potential as far as the minerals and other raw materials required for a chemical industry are concerned. The Mineral Research and Exploration Institute of Turkey (MTA) is the only public body organized to conduct mineral investigations in Turkey and prepare inventories on reserves. The deposits found of economic value are subsequently mined by organizations from either the public or private sector. However, only a small part of that potential is being utilized. Not more than 2% of the GNP comes from mining.

The mineral potential of Turkey can be seen from annex IV, which describes known deposits on the basis of data published by MTA.

The sources of the information in this chapter are: S. Aplan, Mineral Potential of Turkey, 1974; Chemische Industrie VI/1974, XII/1975, and VI, VII and XI/1976; Statistical Yearbook of Turkey 1975.

### Boron salts (borax)

In terms of boron, Turkey is the world's second richest country. A 486-million-ton deposit was discovered by MTA. In addition, Turkey has significant colemanite deposits. In 1972, run-of-the-mine production was 622,444 t of boron salts (429,432 t as concentrate), of which 355,124 t were exported.

There are two Etibank projects in boron:

(a) The Emet Colemanite Development and Concentration Project, under which production started in 1974 and will reach 600,000 t/a (300,000 t/a of 43% $B_2O_3$ concentrate). Of this, 265,000 t will be exported and 35,000 t shipped to the borax and boric acid plant at Bandırma;

(b) The Kirka Natural Borax Project, in which ore production is planned up to 600,000 t to give 400,000 t of concentrates. The project was completed in 1975 and most of the product is marketed abroad. Some of it is shipped to the borax and boric acid plant at Bandırma.

### Phosphates

All the phosphates needed by the fertilizer industry are now imported mainly from Tunisia and Moroooo. Most of the known phosphate deposits in Turkey appear to be in south-eastern Anatolia, partioularly the provinoe of Mardin. Although the known reserves amount to 425 million tons, this figure (according to MTA) does not reflect the true phosphates potential of Turkey. New discoveries will certainly be made in the future.

About 84 million tons of ore out of the known total have a grade of 21.57% $P_2O_5$, while the remainder is of rather poor grade, 10% $P_2O_5$. Deposits with high $P_2O_5$ content are already being mined at Batı Kasrık, and a production of 250,000 t/a of phosphate should start soon at Mazıdağ-Mardin, an Etibank project.

## Coal

The bituminous coal reserves include 149 million tons of visible, 87 million tons of probable, 362 million tons of possible and another 318 million tons of potential, reserves, totalling 916 million tons, all of it in the Zonguldak Coal Basin.

The lignite reserves are estimated to be 5,177 million tons in all, of which 2,866 million tons are classified as visible, 479 million tons probable and 1,832 million tons possible. In addition, 14 million tons visible and 32 million tons probable asphaltite occur at Şırnak-Siirt. The principal lignite deposits are located in the Maraş-Elbistan, Kütahya, Manisa, Muğla, Ankara, Çanakkale, Sivas, Bursa and Thrace districts.

Salable bituminous coal and lignite production in 1974 were 4.6 million tons and 7.54 million tons (7.84 million tons in 1963), respectively.

In Elbistan, where the lignite reserves have been estimated at 3,000 million tons, an electrical power station with a capacity of 1,200 MW has been built with an investment of $910 million. In 1980, the station will supply about 20% of the country's electrical energy demand.

## Petroleum

In 1974, 3,304,000 tons of crude were produced in Turkey and nearly 10 million tons imported to meet the country's need.

The demand for crude in 1977 and 1982 is estimated to be 15 million tons and 25 million tons, respectively.

The import situation will be eased when the pipe-line from Iraq to Turkey is completed (1978-1979). The initial capacity will be 25 million tons per year and will increase to 35 million tons per year.

Turkey has no natural gas.

## Chromium

Turkey is one of the richest countries in chromium resources. Recorded reserves are 34.5 million tons. The chromium districts of Turkey include Bursa, Eskişehir, Fethiye, Antalya, Denizli, Pozantı, Hatay (Antakya), Sıvas, Erzincan and Elâzığ.

Turkish chromium plays an important role on the world market. In 1972, 690,000 t of chromium ore were produced. The 133,000 t of concentrates and 272,000 t of run-of-the-mine ore were exported in 1973.

Etibank plans to produce 140,000 t of concentrate (43% $Cr_2O_3$). Of this, 44,000 t will be exported while 80,000 t will be treated in the new ferro-chrome plant in Kayseri (1976).

## Aluminium

The known and possibly recoverable aluminium in Turkey comes to about 1.5% of the world total. The aluminium ore deposits are found along the Taurus mountain belt and in the Zonguldak basin. Known reserves are 223 million tons.

The new discoveries are promising, particularly in the lake district (Akşehir, Yalvaç, Şarkîkaraağaç and Bucak).

The Seydişehir Integrated Aluminium Plants started to operate in 1973 and will be expanded to produce 200,000 t/a of alumina, of which 120,000 t/a will be used for aluminium production and the rest for export. The bauxite necessary to yield that much alumina (about 470,000 t/a) will come from the Mortaş and Doğankuzu fields.

## Barite

The most important deposits of barite are located in the Konya and Muş districts. The reserves are estimated to be around 50 million tons.

Of the 66,000 t of barite produced during 1972, only a small part (2,400 t) was sorted and washed, the remainder being run-of-the-mine.

## Antimony

Turkey's reserves of antimony are estimated at 1% of the world total. The most important deposit is at Turhal, where the visible ore reserves are 124,000 t.

In 1973, Turkey produced 45.5 million tons of antimony, 3.3 million tons of which were exported.

## Mercury

Turkey has a considerable mercury potential. Exploration has shown that about 10% of the world's mercury is in Turkey. The known deposits are in the Izmir, Manisa, Uşak, Niğde, Kastamonu and Konya districts and amount to 11,700 t in metal equivalent.

Mercury is important for the electrolytic production of chlorine and sodium hydroxide.

The production of mercury metal in 1973 was 305 tons. In future the production rate will rise to 800 t/a, most of which will be exported.

## Fluorite

Fluorite reserves in Turkey add up to 984,000 t; however, only 2,274 t were produced in 1972. In order to meet the local demand, estimated at 4,500 t, the rest had to be imported.

## Sulphur and pyrites

The known sulphur reserves in Turkey are 645,000 t. Only one deposit, Isparta-Keçiborlu, is at present being mined.

In 1973, 81,000 t of run-of-the-mine ore (about 47.67% S) were produced, from which 17,750 t of refined sulphur were produced. Pyrite production was only 45,500 t. About 26,000 t of sulphur were imported in 1974.

## Other minerals

There are many other minerals in Turkey that might have significance for the chemical industry: salt (sea, lake, rock), manganese, copper, lead, zino, marble, limestone, kaolin, bentonite, dolomite, quartz, quarzite, gypsum, feldspar, diatomite etc. (See annex IV.)

## III. THE METHODOLOGY FOR PLANNING THE TURKISH CHEMICAL INDUSTRY

Planning a chemical industry is a complicated matter. From the same raw material, different products may be obtained, and the same (or similar) chemicals can be produced from different raw materials. Normally, chemical processes consist of several, sometimes many steps, involving, and at the same time producing, various intermediates. Some chemicals are manufactured by the gram or kilogram, whereas the production of others is measured in the thousands or millions of tons.

Chemical products penetrate deeply into the over-all economy of a country. They might be called the "work-horses" of technical progress as a whole. They stimulate the social, industrial and economic life of a country. The internal links within various branches of the chemical industry, as well as the external links with many other sectors, increase with the growth of industry and the economy.

The methodology for planning the Turkish chemical industry should consist, first, of a determination of which sectors should be studied and, second, of a detailed analysis of each sector.

### General survey

The expert recommends that in the survey of the chemical industry in Turkey, certain sectors be studied separately. These are:

| Sector | Products |
|---|---|
| Fertilizers | Nitrogen and phosphorus<br>Ammonia, nitric, sulphuric and phosphoric acids |
| Heavy inorganic chemicals | Sodium carbonate and sodium bicarbonate<br>Chlorine and sodium hydroxide<br>Calcium carbide<br>Industrial nitrates and phosphates<br>Hydrogen peroxide<br>Boron derivatives (borax, boric acid, perborates)<br>Chromium salts (dichromates, chromic oxide, chrome yellow)<br>Aluminium, magnesium, copper salts<br>Meroury compc unds<br>Fluorine compounds<br>Titanium dioxide (titanium white)<br>Other inorganic pigments |

| Sector | Products |
|---|---|
| Heavy organic chemicals | Methanol, formaldehyde<br>Acetylene, acetaldehyde, acetic anhydride, acetic acid, methyl and ethyl acetates<br>Acetone<br>Phenol<br>Butanol and octanol (2-ethylhexyl alcohol)<br>Phthalic anhydride and phthalates<br>Melamine<br>Toluylene diisocyanate (TDI) and intermediates for polyurethanes |
| Dyes and intermediates | Aniline, beta naphthol, H-acid, I-acid<br>Acid (basic, direct, disperse)<br>Azo, fluorescent, fibre-reactive<br>Sulphur, solvent, other dyestuffs and chemicals for textile, leather, food and other industries<br>Organic pigments |
| Pesticides | Insecticides<br>Herbicides |
| Detergents and cosmetics | Natural flower oil and synthetic products<br>Synthetic detergent chemicals (Dodecylbenzene, alkyl arylsulphonates, sulphonic alcohols, condensates of ethylene oxide with olefins and other cationics and non-ionics)<br>Cosmetics (lotions, perfumes, skin milk, cremes, powders, lipstioks) |
| Paints, varnishes, resins and adhesives | Resins (urea, phenol, phthalic, furan, polyether etc.)<br>Paints (vinyl acetate and aorylate emulsions, antioorrosive, nitro-cellulose, polyether, for food-canning industry)<br>Adhesives (urea, phenol, epoxy, rubber etc.) |
| Rubber products | Tyres<br>Tyre retreading<br>Industrial rubber products (hoses, belts for conveyors, moulded articles)<br>Recreational rubber produots (tents, pneumatio boats, mattresses eto.) |

| Sector | Products |
|---|---|
| Pharmaceuticals | Salicylic and acetylsalicylic acid<br>Sulphonamides<br>Antipyretics and analgesics<br>Antibiotics (by fermentation)<br>Vitamin C, glucose and sorbitol<br>Animal extracts (hormones, liver, insulin)<br>Vegetable extracts (codeine, digitalis)<br>Synthetic hormones<br>Sedatives and tranquillizers<br>Pre-mixes for animal feeding |
| Others | Chemicals for plastics, rubbers, textiles, leathers etc. (antioxidants, stabilizers, activators, brighteners, catalysts etc.)<br>Analytical grade inorganic and organic chemicals<br>Chemical utilization of various domestic vegetables and animal by-products (e.g., molasses, linters, animal bones) |

The following notes apply to the list above:

(a) Heavy petrochemicals, monomers and polymers are not included in the classification as they are not in the fields of interest to TSKB;

(b) The classification is tentative. In the detailed survey of each sector, it may turn out that other products should be chosen;

(c) Investigation of the final products should be carried out in conjunction with a study of the main intermediates and raw materials.

## Detailed sectoral survey

The following principal issues should be analysed within each sector:

(a) The general factors and indices characterizing the present and forecast development of the country, e.g. population, GNP increase, investments, principal requirements of the Fourth Five Year Plan (1978-1983) etc.;

(b) The actual situation and the principal economic and technological trends in the industrialized countries, e.g., production, total and per capita consumption, imports-exports, new investments, plant sizes, raw materials, cost and price developments. It might be reasonable to investigate the present situation and developments in some countries where significant investments are made in chemical industry, e.g. Algeria, Spain and the countries of eastern Europe. Special attention should be paid to technical and technological development. The main problems are the existing technological methods, their advantages and disadvantages, the use of raw materials and the availability of processes;

(c) The present situation in Turkey, i.e.,the existing capacities and investments (both in the public and private sectors), actual and planned production, raw material availability and the currently used processes;

(d) The present and potential market situation. Since it is a critical factor for the investment planning, special attention has to be paid to the investigation of actual consumption both of domestic production and of imports, the principal patterns of end-use, the extent of increase in the demand of the existing and potential consumers (the increase in demand should be estimated where strict data about the consumption are not available, based on the end-users' expansion factors) etc. The export possibilities, especially to neighbouring countries, should also be investigated and reflected in the market research;

(e) The investment possibilities in Turkey. After the steps above, a preliminary estimation about the proposed capacity, technological process, tentative capital costs, raw material supplies, and other factors and data necessary for a further investigation should be collected and deliberate conclusions should be formulated.

## IV. GENERAL PLAN FOR THE DEVELOPMENT OF THE CHEMICAL INDUSTRY IN TURKEY

The general plan for the Turkish chemical industry is considered under the following main headings: plant size, increase of export possibilities, technological and spatial integration, engineering facilities and short-term investment possibilities.

### Plant size

As previously mentioned, the plants in the private, and partly in the public, sector are below the optimum size. The scale of production and investment that is economical for various chemical products has a critical effect on the development of the chemical industry, especially in the basic heavy chemicals sector.

In the case of chemical end-products, economies of scale are not so important. The most significant source of economies of scale is the reduction in the cost of investment per unit of annual output. The importance of a sharp reduction in labour requirements per unit is relatively minor, because in most cases, labour costs represent a small fraction of the total production costs, especially in the basic chemicals sector.

The relationship between the increases in the capital costs and the annual production capacity is described by the exponential equation

$$C_1/C_2 = (S_1/S_2)^f,$$

where $C_1$ and $C_2$ are the capital costs of the two scales $S_1$ and $S_2$, and the exponent f varies between 0 and 1 according to the chemical process. For the fixed investment, the value of f lies in the range 0.6-0.8, for labour costs, in the range 0.2-0.4.

The table shows the value of f for some chemical products and the range of production capacity S over which the equation above is valid.

Value of f and range of validity of S by product

| Product | f | Range of S (unit: 1,000 t/a) | Produotion route |
|---|---|---|---|
| Sulphuric acid | 0.83 | 200-500 | Sulphur |
| Ammonia | 0.77 | 360-500 | Naphtha, natural gas |
| Calcium carbide | 0.52 | 45-60 | |
| Chlorine and sodium hydroxide | 0.77 | 60-120 | |
| Dichromates | ... | 10-15 | |
| Titanium dioxide | 0.62 | 30-60 | Sulphuric acid |
| Methanol | 0.77 | 100-360 | Naphtha, natural gas |
| Butanol | ... | 15-30 | Acetaldehyde |
| Octanol | ... | 10-20 | Acetaldehyde |
| Ethylene | 0.61 | 200-500 | Naphtha |
| Ethylene oxide | ... | 60-120 | |
| Aniline | ... | 10-20 | Direct reduction |
| Salicylic acid | ... | 1.0 | |
| Acetylsalicylic acid | ... | 0.5-1.0 | |
| Phenol | ... | 30-60 | Cumene |
| Vitamin C | ... | 0.3 -1.0 | |

In some cases, the domestic market, by itself, would not justify the optimal capacity. Therefore, according to the expert's opinion, it is essential that exports be planned and effeoted.

Sometimes there are doubts about the possibilities of absorbing the production of a planned plant. That sometimes leads to a small-scale, high-cost facility being built. Judging by the experience of other oountries the optimal size, even if production capaoity is greater than demand, should be preferred to a small size that meets the demand. The reason is that from the planning stage to the start-up of a plant, a period of 5-7 years usually elapses; meanwhile, the domestio market and export possibilities may substantially change, especially when a certain degree of demand elastioity is assured through sound planning of investments.

## Increasing export possibilities

As pointed out earlier, Turkey exports only small amounts of chemicals; the domestic demand absorbs practically all production. That makes the chemical industrialists oriented toward the home market. However, if exports were possible, plants could be built to optimal size. For this reason, increasing the export of chemicals should be considered in the planning and development of the chemical industry in Turkey.

Turkey has an excellent geographical position as far as the markets in the Near East and northern Africa are concerned. Many chemical products may be manufactured in Turkey at competitive prices, taking advantage of the natural resources, lower labour costs, lower transportation costs etc.

The expansion of exports should be regarded as imperative unified action rather than a case-by-case activity. The expert thus recommends that a specialized export company be established.

## Technological and spatial integration

From the foreign-exchange point of view, an ideal situation exists when the chemical process is totally integrated, relying on non-imported raw materials and intermediates, producing sophisticated end-products and utilizing all by-products from the process. In industrial practice such a situation exists rather rarely and may be achieved only by widening the range of chemical products manufactured in the country. Every project that relies on imported intermediate chemical products undoubtedly increases the amount of foreign-exchange commitments, which are difficult to prune during a period when the balance of trade is unfavourable. Only if investments in new chemical projects are co-ordinated can the commitments be properly balanced from the point of view of national interest. However, even in the absence of total integration, each new step in the backward as well as the forward integration of the process can secure considerable savings in foreign exchange.

The expert's opinion is that some investment opportunities exist in the chemical plants in Turkey today which can increase the speed of integration. The production of a wide range of boron chemicals, the processing of low-grade benzene hexachloride and fluorine gas recovery are only a few examples of the possibilities seen by the expert in his plant visits.

Attention should also be paid to the savings that can be achieved through spatial concentration of the chemical plants. In co-operation with each other, these plants can solve the infrastructure, energy, water-supply, pollution and environmental problems that would be common to them, thus saving investment costs.

The existing plants (both in the private and public sectors) could create a nucleus of spatially integrated complexes of high efficiency.

## Engineering facilities

The expert recommends that the establishment of engineering facilities be considered, with the participation of TSKB. Even at the initial stage such facilities could play an important role in the planning of investments in the Turkish chemical industry. They could be helpful by:

Elaborating feasibility studies

Making decisions about plant size, location etc.

Elaborating engineering activities, designs for expansion and improvements in existing plants

Acting as a consultant for chemical producers and machinery and equipment producers in the chemical industry

Organizing, co-ordinating and supervising the investment processes of individual projects

Utilizing existing expertise for elaborating new projects, without having repeatedly to import know-how and engineering services

Acting as a counterpart in negotiations with foreign partners

Encouraging research in universities and other institutions in Turkey

## Short-term investment opportunities

Independent of the general investigation of several chemical sectors for the identification of opportunities for long-term investments within the chemical industry in Turkey, these ideas for short-term investment have arisen from the discussions and visits in which the expert participated:

Expansion and improvements in integration of existing plants

Calcium carbide connected with the production of butanol and octanol through acetaldehyde

Methanol and eventually oxosynthesis based on lignite

Nitrocelulose from linters

Dichromates and other chromium salts

Various inorganic chemicals for small- and medium-scale production based on domestic minerals, e.g., aluminium, copper and mercury

Aniline, beta-naphtol and other intermediates for dye production

Synthesis of small-scale intermediates for the domestic pharmaceutical industry

Auxiliary chemicals for the textile, leather and other industries

Intermediate products for polyurethane production (TDI, polyols)

Food additives for animal feeding (premixes).

## V. RECOMMENDATIONS

1. The detailed sectoral surveys (chapter III) should be completed by mid-1977; the final analysis of surveys and the identification of investment opportunities could be made with expert assistance.

2. In the survey, special attention should be paid to the following points:

   Optimal plant size
   Integration of processes
   Assumptions about the necessity of exports
   Spatial integration

3. The establishment of engineering facilities should be considered.

4. The list given in chapter IV, last section, should be taken into consideration for the identification of investment opportunities.

5. Further services of an expert should eventually be obtained for the evaluation of the sectoral analysis, the internal co-ordination of sectors and the definitive identification of investment opportunities.

Annex I

JOB DESCRIPTION
(DP/TUR/76/018/11-02/05/32.1.C)

**Post title:** Chemical Industry Planning Expert

**Duty station:** Ankara, Turkey

**Duration:** One month

**Date required:** As soon as possible

**Duties:** The expert will be attached to the Industrial Development Bank of Turkey (TSKB) and will be expected to assist in planning the chemical industry for the country. In particular, he will be expected to carry out the following duties:

1. To review the present situation of the chemical industry in Turkey and to assist the local staff in creating the necessary methodological framework for undertaking a comprehensive survey of the Turkish chemical industry;

2. To review the statistical data about the chemical industry such as production and consumption of chemical materials and products, imports and exports of chemical materials and products etc., and to predict their future trends;

3. To examine the availability of raw materials for the chemical industry;

4. To draw up a general plan for the development of the chemical industry in Turkey;

5. To identify, on the basis of the above plan, investment opportunities in the chemical industry sector.

The expert will also be expected to prepare a final report setting out the findings of his mission and his recommendations to the Government on further actions which might be taken.

**Qualifications:** University degree in chemical engineering or industrial chemistry with extensive experience in the planning of chemical industry and investment promotion

**Language:** English; Turkish an asset

**Background information:** The Industrial Development Bank of Turkey is planning to undertake a comprehensive survey on the Turkish chemical industry. The ultimate aim of the study is to identify investment opportunities in this sector. The Government requests UNIDO to assist in its planning.

## Annex II

PRODUCTION AND PRODUCTION CAPACITY OF CHEMICALS IN TURKEY, 1975

| Product | Production (t) | Capacity (t/a) |
|---|---|---|
| **Fertilizers** | | |
| Ammonium nitrate (21% N) | 55 005 | 60 000 |
| Ammonium nitrate (26% N) | 609 169 | 1 165 625 |
| Ammonium sulphate (20-21% N) | 66 087 | 88 500 |
| Diammonium phosphate (DAP) (18-46-0) | | |
| As N | 121 758 | 322 231 |
| As $P_2O_5$ | 383 603 | 1 023 200 |
| Urea (46% N) | - | 1 125 000[a] |
| Superphosphate, normal (16-18% $P_2O_5$) | 153 981 | 242 000 |
| Triple superphosphate (TSP) (45% $P_2O_5$) | 1 295 751 | 1 610 000 |
| Total nitrogenous fertilizer (calculated as 21% N) | 878 824 | 1 636 356 |
| Total phosphorus fertilizer (calculated as 16-18% $P_2O_5$) | 2 307 388 | 2 867 600 |
| **Industrial chemicals** | | |
| Ammonia | 96 870 | 290 000[b] |
| Butadiene | ... | 33 000 |
| Carbon black | 9 527 | 12 000 |
| Chlorine | 20 000 | 36 000 |
| Dodecylbenzene | 12 800 | 12 000 |
| Ethylene | 43 300 | 60 000 |
| Phosphoric acid | 169 140 | 346 000[b] |
| Sulphuric acid | 392 080 | 1 220 000[b] |
| **Polymers** | | |
| Polyethylene | 25 400 | 27 000 |
| Polystyrene | 1 876 | 15 000 |
| Polyvinyl chloride | 22 620 | 26 000 |
| **Elastomers** | | |
| Cis-butadiene rubber | 1 400 | 13 500 |
| Styrene-butadiene rubber | 6 300 | 32 000 |

Sources: Yapı ve Kredi Bankası, Chemical Fertilizer Industry in Turkey, 1976; PETKIM, Annual Report, 1975; Chemisohe Industrie II/1976; Hydrocarbon Processing X/1976.

a/ For 1976.

b/ Planned for 1977.

## Annex III

IMPORTS OF CHEMICALS INTO TURKEY, 1974 AND 1975

| Product | 1974 | | 1975 | |
|---|---|---|---|---|
| | Amount (unit: 1000 t) | Value (unit: LT 1000) | Amount (unit: 1000 t) | Value (unit: LT 1000) |
| Phosphates, rock | 514.5 | 335.4 | 802.8 | 738.5 |
| Phosphates, pulverised | 74.8 | 41.0 | 96.7 | 97.1 |
| Ammonia | 33.3 | 117.4 | 141.0 | 658.6 |
| Pyrites | 26.8 | 5.2 | 70.0 | 8.3 |
| Sulphuric acid | 129.4 | 101.8 | 350.0 | 275.5 |
| Phosphoric acid | 2.9 | 7.9 | 72.2 | 270 7 |
| Urea | 93.5 | 247.1 | 84.5 | 292.6 |
| Ammonium sulphate | 209.2 | 263.7 | 95.6 | 190.2 |
| Ammonium nitrate | 153.4 | 174.0 | 38.0 | 59.3 |
| Other fertilizers | 421.4 | 962.9 | 86.0 | 274.3 |
| Calcium nitrate | 4.4 | 9.7 | 40.0 | 124.3 |
| Sodium carbonate | 75.3 | 155.9 | 72.4 | 188.0 |
| Sodium bicarbonate | 6.8 | 13.5 | 9.8 | 24.4 |
| Sodium hydroxide | 19.9 | 54.6 | 23.3 | 104.5 |
| Aluminium sulphate | 10.5 | 15.5 | 12.2 | 21.2 |
| Sodium phosphate | 10.9 | 76.1 | 13.3 | 126.0 |
| Zinc oxide | 2.5 | 34.3 | 2.5 | 34.3 |
| Titanium oxide | 1.5 | 22.4 | 2.0 | 25.7 |
| Sodium hydrosulfite | 1.6 | 20.0 | 1.1 | 15.3 |
| Potassium carbonate | 1.2 | 4.3 | 2.7 | 15.3 |
| Sodium perborate | 3.1 | 14.8 | 2.3 | 20.1 |
| Sodium dichromate | 3.1 | 20.6 | 3.3 | 30.3 |
| Hydrogen peroxide (30%) | 2.0 | 10.2 | 3.0 | 23.0 |
| Polyvinyl chloride (PVC) | 20.8 | 261.5 | 21.7 | 189.4 |
| Polystyrene | 6.9 | 71.3 | 16.3 | 150.3 |
| Polyethylene | 25.4 | 250.9 | 26.0 | 242.0 |
| Polypropylene | 5.2 | 52.6 | 12.6 | 94.4 |
| Styrene-butadiene rubber (SBR) | 14.2 | 130.2 | 12.6 | 130.8 |
| Other synthetic rubbers | 4.8 | 45.8 | 5.5 | 65.3 |
| Styrene | 2.2 | 23.3 | 6.8 | 51.9 |

Imports of chemicals (continued)

| Product | 1974 Amount (unit: 1000 t) | 1974 Value (unit: LT 1000) | 1975 Amount (unit: 1000 t) | 1975 Value (unit: LT 1000) |
|---|---|---|---|---|
| Xylol | 9.7 | 36.9 | 14.9 | 39.2 |
| Phenol | 2.7 | 36.9 | 3.8 | 26.6 |
| Phthalic anhydride | 0.5 | 5.0 | 2.5 | 29.6 |
| Phthalates | 20.8 | 250.3 | 23.0 | 205.0 |
| Other aromatics | 3.6 | 59.6 | 5.4 | 86.2 |
| Acetone | 1.8 | 12.7 | 2.8 | 10.4 |
| Methanol | 9.0 | 23.3 | 11.9 | 19.8 |
| Ethylene glycol | 10.4 | 120.7 | 11.3 | 106.8 |
| Other glycols | 8.0 | 68.6 | 12.5 | 105.3 |
| Chlorofluoroethane | 1.4 | 13.8 | 2.7 | 33.1 |
| Sulphamides | 0.11 | 22.5 | 0.15 | 36.5 |
| Vitamin C | 0.13 | 11.5 | 0.14 | 16.7 |
| Corticosteroids | 0.001 | 18.5 | 0.003 | 34.0 |
| Other hormones | 0.008 | 9.2 | 0.015 | 15.7 |
| Codeine | - | 0.01 | 4.0 | 24.6 |
| Penicillin | 0.069 | 33.5 | 0.114 | 63.5 |
| Chloromycetin | 0.017 | 10.9 | 0.031 | 20.5 |
| Erythromycin | 0.016 | 13.8 | 0.013 | 20.0 |
| Dyes | | | | |
| Direct | 0.181 | 15.0 | 0.225 | 28.2 |
| Pigments | 0.5 | 45.6 | 0.6 | 67.4 |
| Reactive | 0.6 | 102.6 | 0.5 | 111.4 |
| Azo | 0.3 | 19.2 | 0.2 | 16.9 |
| Other | 0.4 | 54.3 | 0.4 | 79.0 |
| Optical brighteners | 0.2 | 11.5 | 0.2 | 17.2 |
| Varnishes | 0.7 | 15.9 | 0.8 | 24.9 |
| Paints | - | 2.1 | 0.4 | 18.7 |
| Nonionic surface-active agents | 1.0 | 15.3 | 1.3 | 28.6 |
| Pesticides | 0.8 | 33.6 | 1.2 | 69.4 |

Source: Industrial Development Bank of Turkey (TSKB).

## Annex IV

### KNOWN MINERAL DEPOSITS IN TURKEY

| Mineral | Reserves[a] (unit: 1000 t) | | Grade or quality of deposit | Remarks |
|---|---|---|---|---|
| Aluminium | 223 100 | v,pr | 40-60% $Al_2O_3$ | Bauxite and diasporite, plus over 150 million tons possible reserves |
| Antimony | 124 | v | 11-13% $Sb_2O_3$ | Turhal only |
| Copper | 240 970[b] | v,pr | Various | |
| Lead | 81 688[b] | v,pr | Various | |
| Zinc | 313 782[b] | v,pr | Various | |
| Mercury | 12 | v,pr | Metal | |
| Iron | 522 600 | v,pr | Recoverable | Plus 18.1 million tons possible and 247.8 million tons possible to a lesser degree |
| Chromium | 34 500 | v,pr | 30-50% $Cr_2O_3$ | Geology points to some possible reserves as well |
| Tungsten | 15 000 | v,pr | 0.362% $WO_3$ | Ulu Dağ only |
| Manganese | 10 000 | v,pr | Various | A further 20 million tons possible |
| Asbestos | 5 115 | v,pr,p | Amphibole, chrysotile | Reserves given as ore |
| Barite | 50 000 | v,pr,p | 70-96% $BaSO_4$ | |
| Boron | 502 000 | v,pr | 28-43% $B_2O_5$ | |
| Phosphate | 425 000 | v,pr,p | 7-30% $P_2O_5$ | 83.4 million tons suitable for mining with a grade of 21.57% $P_2O_5$ |
| Clay, kaolin | 150 000 | v,pr | Various | |
| Sulphur | 645 | v | 40-76% S | |
| Diatomite | 108 870 | | Good quality | |
| Perlite | 6 585 000 | | ... | |
| Magnesite | 56 600 | v,pr,p | Good quality | |
| Meerschaum | 1 200 000 | v,pr,p | ... | |

Known mineral deposits (continued)

| Mineral | Reserves[a] (unit: 1000 t) | Grade or quality of deposit | Remarks |
|---|---|---|---|
| Sodium sulphate | 3 670 | | In lake waters |
| Fluorite | 984 v,pr,p | Various | |
| Marble | $10^9$ | ... | Over 400 varieties |
| Alunite | 9 400 v,pr,p | ... | Visible and probable |
| Coal | | | |
| Bituminous | 916 000 v,pr,p | ... | All in the Zonguldak coal basin |
| Lignite | 5 177 000 v,pr,p | Various | |
| Asphaltite | 56 000 v,pr | 3000-6000 | |
| Uranium | 4 v,pr,p | $U_3O_8$ | |
| Thorium | 10 v,pr,p | $ThO_2$ | |

Source: S. Alpan, Mineral Potential of Turkey, Ankara, 1974.

a/ The reserves are described as visible (v), probable (pr) or possible (p).

b/ At an equivalent grade of 1%.

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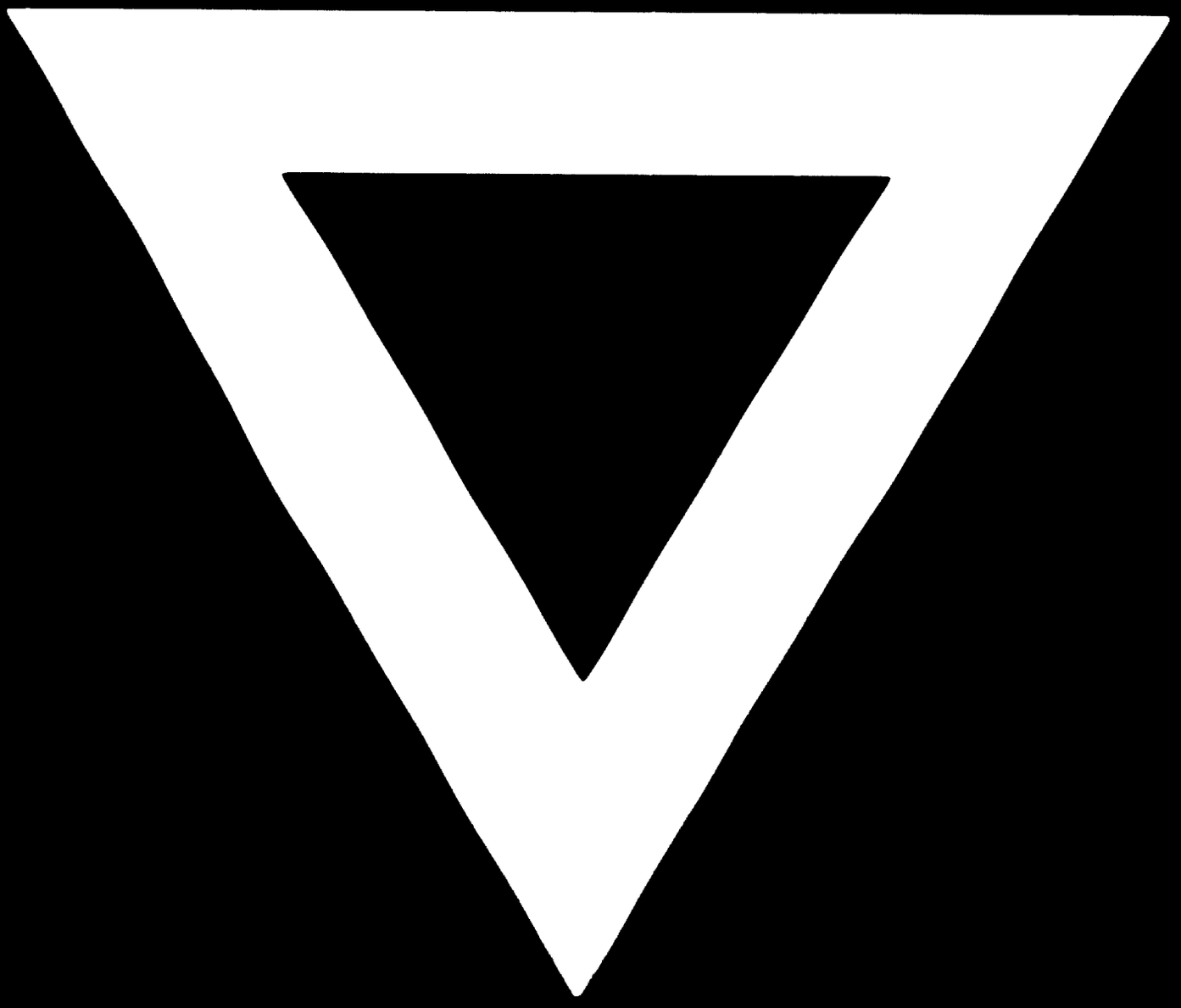

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