MINISTRY OF THE ENVIRONMENT

MINERAL RESOURCES OF POLAND

POLISH GEOLOGICAL INSTITUTE
WARSAW 2000

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Dear Reader,

Deposits of mineral resources as an unrenoveable part of the environment are the basis of the industry's development. Knowledge of domestic mineral resources is indispensable for considerations on the national economy. For 46 years the polish geological survey has been preparing a report „Raw Material and Groundwater Resources Balance of Poland" (in Polish). Because of a high appreciation of value and suitability of this work - a paper „Mineral Resources of Poland" under presentation has been prepared in English as the second edition.

The enclosed data present an actual state of geological identification of the deposits of mineral raw materials in Poland. Summarised informations on of the output and domestic import and export main mineral raw materials are showing potential possibilities and development lines of the basic branches of mining and processing industries.

The „Mineral Resources of Poland" present an important source of information for readers interested in the development of mining and processing industries or in using domestic raw materials in their investments in Poland.

Dr inż. Tadeusz Bachleda-Curuś

Bachleda

Undersecretary of State
Chief Geologist of the Country

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INTRODUCTION

In the period of four years since the last edition of "Mineral Resources of Poland", the discoveries of new crude oil and natural gas fields, making the resource interpretation of many mineral products such as hard coal more accurate, by limiting the resource estimation to the depth of 1,000 metres, that is to the zone available for the mining activity, as well as introducing many new deposits of common mineral products into the national resource base have been the most considerable changes.

Among various deposits of mineral products in Poland, the energetic mineral products, in particular hard coal, lignite and natural gas as well as still scarce resources of crude oil are constantly of supreme importance. The copper and silver deposits from which other metals can be obtained are very important as well as zinc and lead ores, however of slightly less significance. The vast, although falling in value, deposits of indigenous sulphur, halite and numerous deposits of other mineral products representing a raw materials base for the building, ceramic, lime and cement industries as well as other sectors of the national economy illustrate the abundance of natural resources, the Geological Resources of which to be found in more than 8,200 deposits are estimated at 198 milliard tons.

Registration of changes in the mineral product resource base is carried out by the Polish Geological Institute in the System of Management and Protecting of Polish Mineral Raw Materials MIDAS. At present, data on 8,263 deposits of various raw materials are gathered in the system base. The system was the source of data for preparing the paper ''Balance of Raw Material and Groundwater Resources in Poland". The publication, in Polish, has been issued annually since 1953.

The Polish version of the "Balance of Raw Material and Groundwater Resources in Poland as of 31 December, 1999" was used as a basis for the present publication "MINERAL RESOURCES IN POLAND". The tables concerning the resources, output as well as Polish exports and imports of mineral raw materials have been taken from the Polish edition.

Raw materials are presented in alphabetical order. The tables summarising the volume and the directions of imports and exports show only raw materials of major importance in the international turnover. The criterion for including the particular raw material in the table was the volume of its imports and exports in 1999, which had to reach the minimum value of PLN 10,000 thousand. The number of countries in the tables has been limited, in principle, to those whose turnovers with Poland amounted to not less than PLN 500 thousand.

The terminology and classification of the resources used in this paper is an attempt to adapt the national classification to the United Nations International Framework Classification for Reserves/Resources (Solid Fuels and Mineral Commodities) in principle accepted by the UN Economic and Social Council in Geneva, in 1996 (Workshop -1995, Energy/ WP.1R.77 -1997). The work on improvement and acceptation of the terminology is being carried on in non-European countries (Guidelines to the United Nations International Framework classification for reserves/resources 2000). The United Nations International Classification for Reserves/Resources is presented in Table I.1.

The adaptation of Polish terminology to the UN Classification standards is a continuation of such attempts (M. Nieć, 1995; M. Piwocki, S. Przenioslo, 1997; M. Nieć, M. Piwocki, S. Przenioslo, 2000). The greatest terminological difficulties in the translation into English concerned the classification of resources. For instance, it worthy of notice that no distinction is made in Polish between the terms "reserves" and "resources" and they are expressed by one word "zasoby". This is reflected in the presentation of the total national resources. The Polish geological survey is responsible for balancing, on the national level, the Resources base which is established in a geological study, while part of the base, i.e. Economic Reserves (Proved Mineral Reserves in place and/or Probable Mineral Reserves) is shown as "including". Economic Reserves are specified in documents which correspond to Prefeasibility Study (Projekt zagospodarowania złoża) or Feasibility Study (Plan ruchu zakładu górniczego)

For better understanding and making possible the use of the original Polish publications concerning the management of resources, we present below the UN classification (Table I.1), followed the corresponding Polish terms.

Table I.1 United Nations International Classification for Reserves/Resources with Polish terms

<table>
<tr><th colspan="2" rowspan="2">UN International Framework</th><th>Detailed Exploration</th><th>General Exploration</th><th>Prospecting</th><th>Reconnaissance</th></tr>
<tr><th>Polish System</th><th>Rozpoznanie wstępne
(A + B)</th><th>Rozpoznanie szczegółowe
C_1</th><th>Poszukiwanie
C_2 (D_1 ?)</th><th>Penetracja
D_1, D_2</th></tr>
<tr><td rowspan="2">Feasibility Study and / or Mining Report</td><td rowspan="2">Plan ruchu zakładu górniczego, Operat ewidencyjny zasobów złoża</td><td>1. Proved mineral reserve (Przemysłowe)
(111)</td><td rowspan="2">usually</td><td rowspan="3">not</td><td rowspan="3">relevant</td></tr>
<tr><td>2. Feasibility mineral resource (Nieprzemysłowe)
(211)</td></tr>
<tr><td rowspan="2">Prefeasibility Study</td><td rowspan="2">Projekt Zagospodarowania Złoża</td><td colspan="2">1. Probable mineral reserve (Przewidywane przemysłowe)
(121) (122)</td></tr>
<tr><td colspan="2">2. Prefeasibility mineral resource (Niezakwalifikowane do przemysłowych)
(221) (222)</td></tr>
<tr><td>Geological Study</td><td>Dokumentacja geologiczna</td><td>1 - 2 Measured mineral resource (Geologiczne A+B)
(331)</td><td>1 - 2 Indicated mineral resource (Geologiczne C_1)
(332)</td><td>1 - 2 Inferred mineral resource (Geologiczne C_2)
(333)</td><td>? Reconnaissance mineral resource (Perspektywiczne)
(334)</td></tr>
</table>

Mineability Categories: 1 - economic, 1 - 2 - intrinsically economic (I E R) (economic to potentially economic)
2 - potentially economic ? - undetermined

For the most important Polish raw materials (see Table I.2), Total Resources have been compiled, together with Economic Reserves they contain, according to the national system, as well as Resources, Reserves and Remaining Resources, in accordance with the UNFC international classification. It is an attempt to show a simplified representation of the national raw material

potential, as at 31st December 1999. The simplification consists in omitting Sumbmarginal economic in Geological Study level. Geological Resource (Economic to potentially economic) (in Polish: 'zasoby bilansowe') has been indicated by an abbreviation IER (Intrinsically Economic Resources).

Table I.2 The Resources/Reserves of most important raw materials in Poland (in million tons)

Raw material	Total Resources I E R *	including: Economic in-situ	I E R * (331+332+333)	Reserve economic in-situ (111+121+122)	Remaining Resources (211+221+222)
Backfilling sands	5,183.23	311.15	3,958.81	311.15	913.27
Barite	5.45	-	5.45	-	-
Bentonites	3.21	1.76	1.35	1.76	0.10
Building ceramics raw materials	3,992.92	481.14	3,242.52	481.14	269.26
Ceramic clays	142.34	12.12	136.21	12.12	4.01
Chalk	194.19	18.01	170.75	18.01	5.43
Clay raw material for cement production	250.44	26.94	218.78	26.94	4.72
Copper**)	49.84	16.58	18.86	16.58	14.40
Crude oil***)	14.04	10.93	3.11	10.93	2.66
Diatomiceous rock	10.03	0.32	8.99	0.32	0.72
Dimension and crushed stones	8,014.27	2,968.79	4,142.74	2,968.79	984.18
Dolomites	341.28	156.46	157.56	156.46	27.26
Feldspar raw materials	88.90	3.41	75.57	3.41	9.92
Foundry sands	355.75	72.36	233.89	72.36	52.07
Glass sands	607.33	207.04	280.09	207.04	120.20
Gypsum and anhydrites	269.76	112.71	145.75	112.71	11.3
Hard coal	46,846.28	8,354.33	28,694.28	8,354.33	9797.67
Kaolin	208.63	67.80	132.67	67.80	8.16
Lead **)	3.43	0.68	2.57	0.68	0.18
Lignite	14,050.71	1,877.76	11,599.81	1,877.76	573.14
Limestones and marls for cement industry	12,653.15	2,657.81	8,379.29	2,657.81	1,695.13
Limestones and marls for lime industry	5,026.36	1,361.34	3,410.55	1,361.34	254.47
Magnesites	11.84	5.51	6.10	5.51	0.23
Natural aggregates	14,464.04	1,995.22	11,282.04	1,995.22	1,186.78
Natural gas ****)	148,989.96	77,137.30	30,340.66	77,137.30	41,511.70
Peat	43.82	8.64	22.21	8.64	14.15

Raw material	Total Resources I E R *	including: Economic in-situ	I E R * (331+332+333)	Reserve economic in-situ (111+121+122)	Remaining Resources (211+221+222)
Potassium salts	669.12	-	669.12	-	-
Quartz sands for prod. of cellular concretes	481.48	86.74	364.32	86.74	30.42
Quartz sands for prod. of lime-sand brick	236.12	25.52	197.64	25.52	12.96
Refractory clays	57.16	4.86	49.48	4.86	2.82
Refractory quartzites	16.23	8.36	6.88	8.36	0.99
Refractory shales	11.18	-	11.18	-	-
Rock salt	80,201.00	7,382.75	71,738.00	7,382.75	1,080.25
Siliceous earth	2.22	-	2.22	-	-
Silver (in thousand tons)	140.88	43.55	60.12	43.55	37.21
Sulfur	504.56	107.58	343.32	107.58	53.66
Vein quartz	6.84	1.95	2.77	1.95	2.12
Zinc **)	7.45	1.57	5.38	1.57	0.50

* IER (Intrinsically Economic Resources, Economic to Potentially Economic).
**) Metal contents
***) Resources/Reserves extractable in million tons
****) Resources/Reserves extractable in million cubic meters

The use of Terms and their Definitions, as they are understood in the present paper, is given in the Glossary constituting the last part of the present publication. It deserves nothing that the estimation of the Polish resources base has been made at the "Geological Study" level. The reserves explored in detail on the basis of the Prefeasibility Study or Mining Report have been reckoned among the total quantity of Resources - explored in Geological Study, thus the Total Mineral Resources include the Mineral Reserves.

1. AMBERS

The amber ascertained in Poland occurs in Tertiary and Quaternary formations (Fig. 1.1).

The biggest accumulations of amber in Tertiary sediments are connected in the northern and southern marginal zones of the Eocene Sea.

In the northern zone amber has agglomerated in the sandy-silty sediments with glauconite in the Eridan river delta (the so-called Chłapowo-Sambia delta) and this material has been transported by the river from Fennoscandia. Now this area lying in the Gulf of Gdańsk (Zatoka Gdańska) zone has the greatest concentrations of amber. The best explored is the Chłapowo region where the amber-bearing stratum of almost 18 m thick was discovered at a depth of about 100 m, and has a maximum capacity 6 kg/m^3. The magnitude of the resources was estimated at about 640 tons (M. Piwocki 1995).

In the southern zone of the Eocene Sea the amber-bearing sediments (silts and sands with glauconite) were also formed in the delta zone, the so-called Parczew delta. The recharge area was the Ukraine shield. Similar sediments were accumulated at the same time in Ukraine in the Klesów delta (Kijów and Charków series). In the Parczew region the amber deposit has been well explored at the bottom of the Górka Lubartowska natural aggregate deposit. Here the amber-bearing stratum about 7 m thick occurs at an average depth of 15 m. Within this deposits the resources have been estimated at about 10 tons (B. Kosmowska-Ceranowicz 1995).

The third amber occurrence in Tertiary sediments is the Możdżanowo region near Słupsk in the northern Poland. Ambers occur here in the Lower Oligocene and Pliocene sands and gravels, which form a post-glacial cake between Quaternary sediments. The amber-bearing series lie at a depth of 11 m and is on an average of 1.7 m thick. The perspective resources of these areas are estimated at over 20 tons. Within the Możdżanowo natural aggregate deposit 10 tons of amber have been explored in detail (I. Olkowicz-Paprocka 1995).

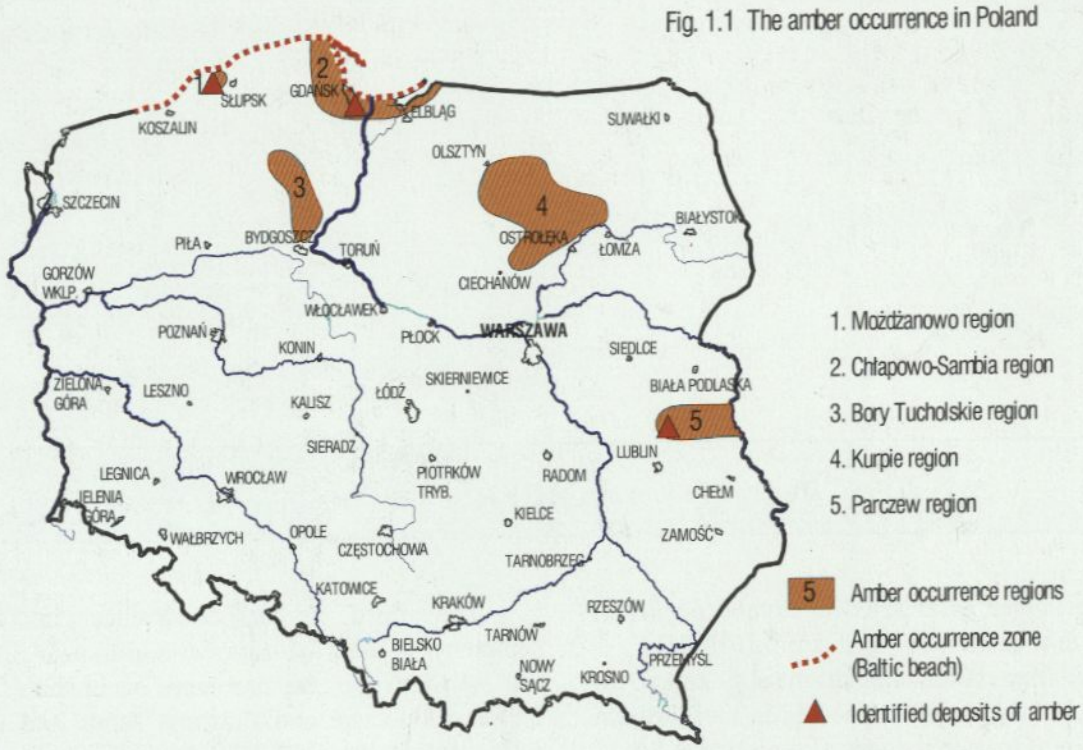
The biggest Quaternary sediments of amber were accumulated due to the glacier and post-glacial rivers transport from Tertiary sediments (mainly from sediments of the chłapowska-sambijska delta).The greatest amber concentrations have been discovered in Kurpie and also in the Bory Tucholskie region where it occurs in outwash fan measures (Fig. 1.1).

Big amber concentrations are also encountered on the Baltic beaches from Kołobrzeg to the eastern border of Poland where this raw material occurs in the fossil measures of Holocene beaches.

About 600 explored amber occurrences have been ascertained in Poland.

It is estimated that consumption of amber in Poland (mainly in jewellery) amounts to about 150 - 220 tons per year. The raw material comes mainly from imports. The remaining demand is balanced by deliveries from amber collectors or from unlicensed exploitation sites (washed out). From this source comes from 20 to 30 tons of amber per year.

Fig. 1.1 The amber occurrence in Poland



2. ARSENIC

The only arsenic ore deposit in Poland occure in Złoty Stok in the Sudetes, where arsenic is accompanied by gold. The arsenic ores are not exploited both for the lack of demand and the toxic properties of the element as well.

The arsenic ore resources were explored in 1954 and amounted to 714 thousand tons of ore which contained 25.5 thousand tons of arsenic. When the exploitation was abondoned in 1960, the remaining resource amounted to 536 thousand tons and contained 19.6 thousand tons of As and about 1,500 kg of Au.

3. BACKFILLING SANDS

Deposits of sands useful as backfilling were identified in the area of intensive, underground mining activities mainly of coal and of copper ores, i.e. in the Upper Silesia (Górny Śląsk) (Plate 8). An important balance criterion for this raw material is the distance between the deposit and the mines using stowages, this distance should not exceed 50 km.

In the Upper Silesian Coal Basin (Plate 8) four regions of the occurrence of backfilling sands can be distinguished. The eastern region (where the largest amounts of the raw material are exploited) where the following measures occur: sandy sediments of fluvioglacial and aeolian accumulation of the Błędowska Desert (with a maximum thickness of 70 m); sandy sediments of outwash fans near Dziećkowice and Imielin; sandy fluvial sediments 11 m thick near Kuźnica Warężyńska; sands of accumulation terraces on the Vistula river bank near Oświęcim.

The western region includes the south-eastern margin of the Silesia Upland and part of the Racibórz Basin. Sandy-gravel sediments 15 m thick occur here in the Odra proglacial valley which are connected with the Middle Poland Glaciation.

The northern region includes wide area of the Mała Panew river valley where thick covers (maximum 40 m) of fluvioglacial, aeolian and fluvial sands occur.

The southern region lying between Żary, Oświęcim and Tychy is a wide area of occurrence of fluvioglacial sands of 20-25 m thickness.

The Lower Silesian Coal Basin is poor in backfilling sands. Sandy and sandy-gravel sediments of fluvioglacial accumulation of about 10 m thickness occur near Jaworzyna Śląska.

In the region of copper ore exploitation near Lubin, between Przemków, Chocianów and Legnica sand-gravel outwash fans occur, which are connected with the Middle Poland Glaciation and have a thickness of max. 40 m.

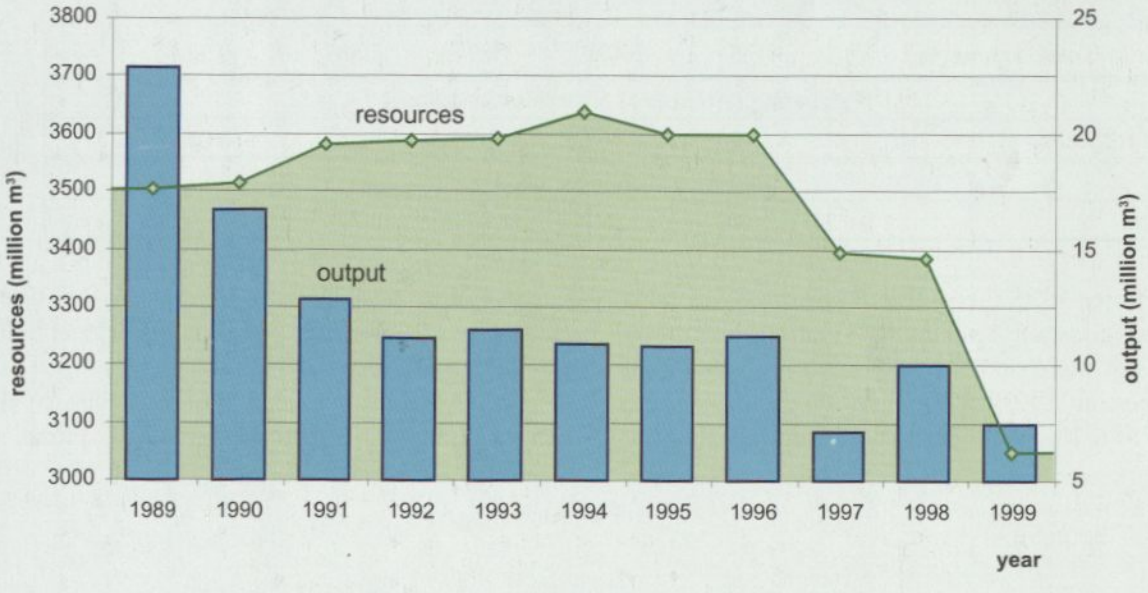
The resources of this raw material amount to 3,049 million m^3, i.e. 5,183 million tons.

The resources of backfilling sand, and state of their identification and management are presented in Table 3.1.

Table 3.1 Backfilling sands (million m^3)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**34**	**3,048.96**	**2,465.29**	**583.67**	**798.50**	**183.03**
including reserves of exploited deposits						
Total	10	720.25	574.16	146.09	312.10	183.03
including resources of not exploited deposits						
Total	19	2,151.21	1,723.54	427.67	301.26	-
1. Exploration	15	1,810.89	1 720.73	90.16	161.21	-
2. Prospecting	4	340.33	2.82	337.51	140.05	-
including abandoned deposits						
Total	5	177.50	167.59	9.91	185.14	-

Fig. 3. 1 Backfilling sands resources and output in Poland in 1989-99



Resources explored in detail amount to almost 81 % of the total quantity of the total resources.

The output of backfilling sands in the recent year amounted to 7,469 thousand m^3 (i.e. 12,697 thousand tons) (Fig. 3.1).

The mining wastes connected with the exploitation of backfilling sands amounted to 148 thousand tons, all of which were collected on dumps.

Possibilities exist of deposits in the area of Lublin Coal Basin. In the northern part of this basin, upland outwash fans of thickness of 20-25 m occur, in the Lubartów region shallow outwash fans covers occur and in the Wieprz river valley sands forms accumulation terrace with thickness of about 15 m. These regions have not been explored yet.

4. BARITE AND FLUORSPAR

Barite deposits occur in Lower Silesia (Dolny Śląsk) and the Holy Cross Mountains (Góry Świętokrzyskie) (Plate 4).

In the Lower Silesia four deposits have been explored, and two of them (Boguszów and Stanisławów) exploited. Barite has not been exploited in Poland since 1998.

Barite of the Lower Silesia deposits occurs in fissures in the form of veins of varying length and thickness, and with a high dip. It occurs in paragenesis with calcite, fluorspar, sulfides and metal oxides. The average content of $BaSO_4$ amounts to about 80 %. Fluorspar forms irregular bands. Its content ranges from a few to over a dozen and so percent and usually increases with depth.

In the Holy Cross Mountains (Góry Świętokrzyskie) barite occurs in Strawczynek in the Lower Devonian carbonate rocks in the form of irregular nests and bands. This deposit is not exploited in view of its low $BaSO_4$ content (about 30 %) and small size of the resources.

The barite resources and the present state of their identification and management are presented in Table 4.1.

The resources and output of barite in the period 1989-1999 are presented in Fig 4.1.

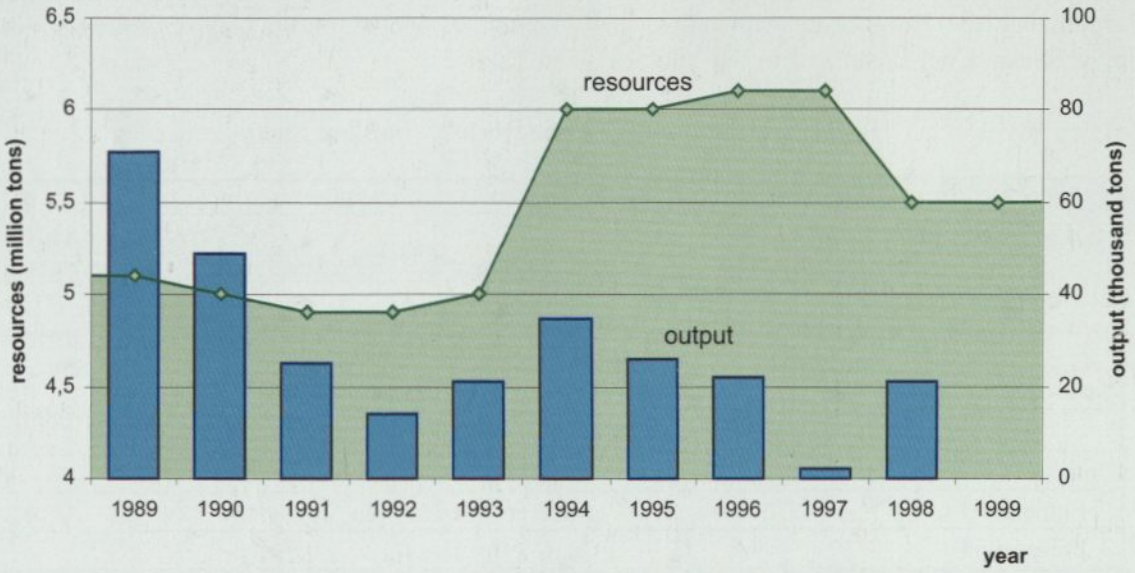
Table 4.1 Barite (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**5**	**5.45**	**1.87**	**3.58**	**0.92**	**-**
including resources of not exploited deposits						
2. Prospecting	1	0.36	-	0.36	0.08	-
including abandoned deposits						
Total	4	5.09	1.87	3.22	0.84	-

Since 1993 the state of resources has been almost constant amounting to about 5 million tons. An increase of these reserves was noted in the period 1993-1997 when they reached the level of 6.3 million tons. The resources of barite decreased to 5.54 million tons again because the Boguszów deposit was flooded during the flood of this region of Poland in 1997.

In the Lower Silesia the resources of 373.7 thousand tons of barite-fluorspar were explored.

Fig. 4. 1 Barite resources and output in Poland in 1989-99



Since 1998 the whole demand for barite and fluorspar in Poland is covered by imports. Imports of barite, witherite and barium compounds amounted in 1999 to 14.1 thousand tons (Table 4.2).

The import of fluorspar and fluorine compounds amounted to 9.8 thousand tons in 1999.

In the same period of time, 0.2 thousand tons of barite and barium compounds as well as 1.1 thousand tons of fluorine compounds were exported.

Table 4.2 Directions of Polish import of barite and barium compounds, and fluorspar and fluorine compounds

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Barite and barium compounds							
	Total	**14.11**	**14,920**				
1	Germany	3.06	5,372	3	Slovakia	5.99	2,778
2	China	2.23	3,003	4	Russia	1.88	2,190
Fluorspar and fluorine compounds							
	Total	**9.84**	**10,878**				
1	Germany	0.60	2,342	4	Mexico	2.97	1,574
2	Czech Rep.	1.43	2,062	5	France	0.32	1,305
3	China	4.08	2,053				

5. BENTONITES AND BENTONITIC CLAYS

Bentonitic raw materials are clay rocks, whose dominant component (determining their utilized properties) are minerals of the smectite group. Bentonites are altered rocks of the same structure as the primary rocks. Bentonitic clays are bentonites in secondary deposits, which were redeposited sometimes at large distances. They contain various, sometimes considerable amounts of foreign components. Bentonites and bentonitic clays differ as regards the percentage of minerals

from the smectite group. Their content in bentonites exceeds 75 %.

In Poland, bentonitic raw materials occur in the Carpathians, the Holy Cross Mountains, in the Upper Silesia Coal Basin and in the Sudetes (Plate 7). The resources of bentonite raw materials amount to 3.21 million t.

The state of identification and management of bentonites and bentonitic clay resources is presented in Table 5.1.

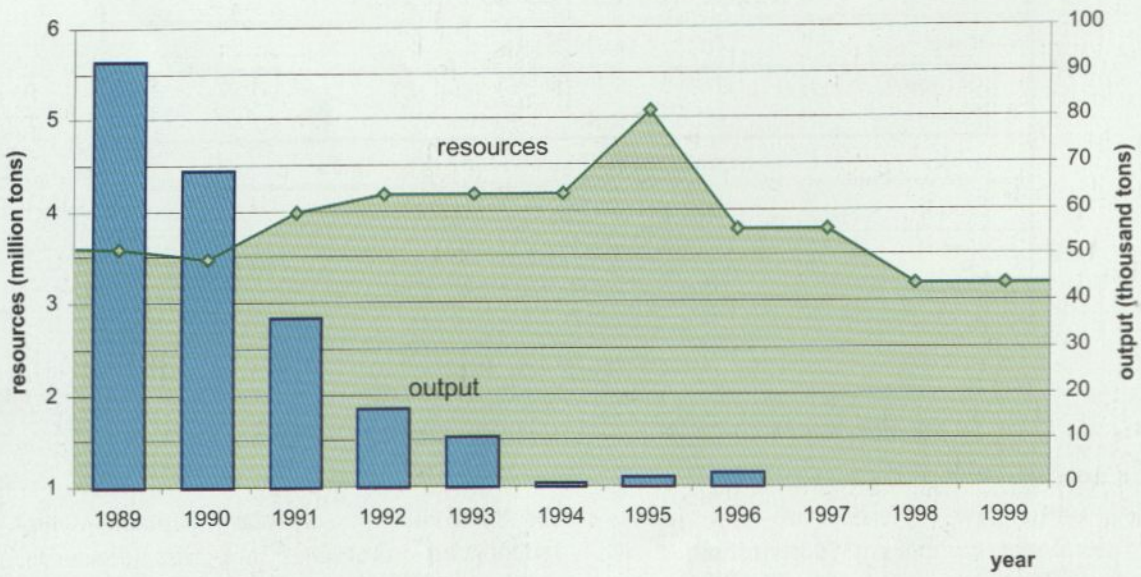
Table 5.1 Bentonitic raw materials (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**9**	**3.21**	**1.49**	**1.72**	**0.25**	**1.76**
including reserves of exploited deposits						
Total	2	0.99	0.78	0.21	-	0.89
including resources of not exploited deposits						
Total	4	2.15	0.70	1.45	0.25	0.87
1. Exploration	2	1.23	0.70	0.53	0.25	0.87
2. Prospecting	2	0.92	-	0.92	-	-
including abandoned deposits						
Total	3	0.07	0.01	0.06	0.01	-

These raw materials were utilized in the founding industry as a founding bentonite of 3rd class, as decolouring earth and also as a component of drilling fluids.

In Fig 5.1 resources and output of bentonitic raw materials in Poland in the years 1989-1999 are presented.

Fig. 5. 1 Bentonites and bentonitic clays resources and output in Poland in 1989-99



Only one deposit has been exploited (Krzeniów) lately. The maximum output of these raw materials amounted to almost 100 thousand tons in the beginning of the last decade. Since 1997 exploitation has been abandoned. This was connected with the low quality of the raw material, which does not allow production of high quality founding materials, and limits the applications and demand for use as drilling fluid. Higher quality bentonites are imported. Imports amounted to 60.3 thousand tons in 1999 (Table 5.2).

Table 5.2 Directions of Polish import of bentonite

.	Country	thousand tons	thousand PLN
	Total	**60.33**	**16,832**
1	Slovakia	46.94	5,480
2	Germany	7.86	5,032
3	United Kingdom, the	0.82	2,369
4	France	0.64	1,082
5	USA, the	0.18	865
6	Denmark	0.56	620

6. BUILDING CERAMICS RAW MATERIALS

Poland is rich in deposits of building ceramics raw materials. They are distributed almost throughout the country in all regions. Building ceramics raw materials are the first of all clay Quaternary and Tertiary sediments, and rarely older ones: Cretaceous, Jurassic, Triassic, Permian, Carboniferous and Cambrian. Quaternary measures, mainly glacial and fluvioglacial sediments, i.e. glacial tills, silts, marginal lake clays, commonly occur in northern and central Poland, and aeolian sediments (loesses) in southern Poland. Older than Tertiary clay sediments occur almost solely in southern Poland (Plate 5).

The clay sediments of Miocene and Pliocene and also the Quaternary marginal lake clays and silts are raw materials of fundamental meaning because of a good quality, common occurring and big resources.

The resources of building ceramics raw materials, as well as the state of their identification and management are shown in Table 6.1. The resources of building ceramics raw materials totalled at the end of 1999 1996 million m^3 (equivalent to about 3,992 million tons).

Table 6.1 Building ceramics raw materials (million m^3)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**1,199**	**1,996.46**	**626.92**	**1,369.54**	**51.35**	**240.57**
including reserves of exploited deposits						
Total	424	340.30	284.31	55.99	9.12	205.67
including resources of not exploited deposits						
Total	303	1,456.20	160.29	1,295.91	22.45	14.02
1. Exploration	226	210.13	160.29	49.84	11.74	14.02
2. Prospecting	77	1,246.07	-	1,246.07	10.72	-
including abandoned deposits						
Total	472	199.96	182.32	17.64	19.77	20.89

The resources of deposits in exploitation amount to 17 % of the total resources, the resources in deposits not exploited amount to 73 % (including 10.5 % of resources in deposits explored and 62.5 % in prospected deposits) and the abandoned deposit resources to 10 %.

The economic reserves heve been estimated as yet for 420 deposits (out of the 424 exploited deposits) and they total 240.57 million m^3 (i.e. about 481.14 million tons), which constitutes 64 % of the exploited deposits.

In 1999, the output amounted to 2,973 thousand m^3 (about 5,946 thousand tons). About 50 % of the exploited raw material are exploited from the Tertiary clays and silts deposits, 30 % from the Quaternary marginal lake clays and silts, 10 % from the Quaternary glacial tills and the Jurassic sediments, 10 % from other deposits. The building ceramics manufacture industry is very much fragmented in Poland, with over 400 firms operating in the market.

The exploitation conducted by the 30 biggest producers of this raw material amounted to 50 % of the total output. Some of the producers exploit almost over 100 thousand m^3 of the raw materials per year. The output of 300 smaller firms constitutes only 20 % of the total output. The smaller producers are often active only periodically, depending on the state of the market.

Each of them exploits maximum 5 thousand tons of the raw material per year. In 1999 the biggest output was in the south of Poland, and also in the Kalisz-Częstochowa region, Warsaw region and in the north of the country (Olsztyn and Lębork regions). The prognostic total resources of building ceramics raw material are estimated at 3,442 million m^3 as of 1st January 1981.

This forecast, however, relates only to resources of clay raw materials suitable for hollow and thin-walled products and light-weight ceramic aggregate ("keramzyt"). It is assumed that poorer quality raw materials (for full brick production) are distributed in large amounts all over the country. The minimal deposit reserves taken into consideration were those of 0.8 million m^3.

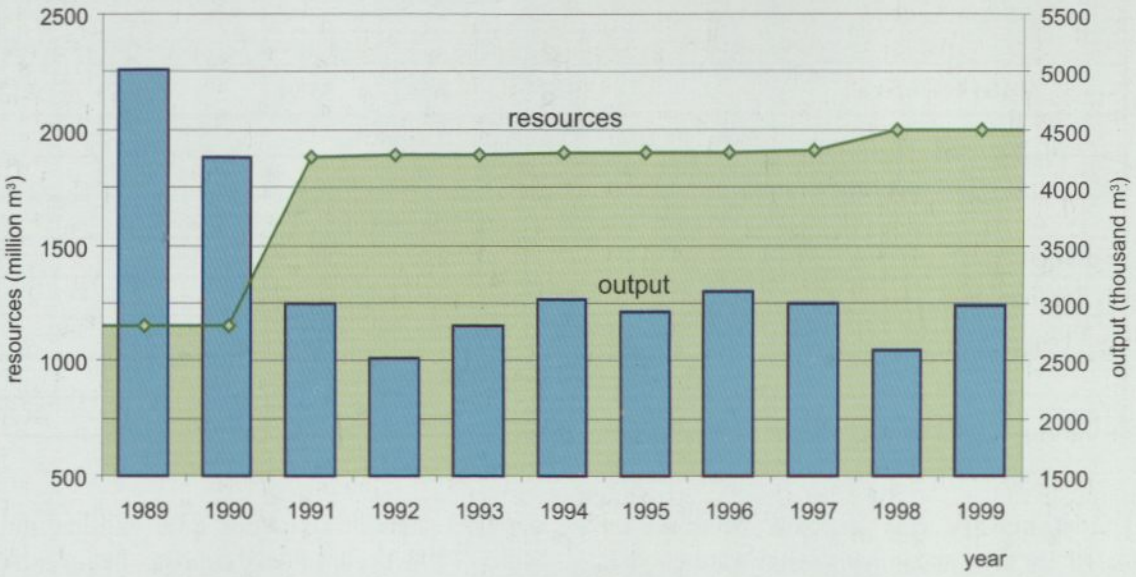
Table 6.2 Types of building ceramics raw materials and their main applications

Age		Raw material	Main uses					
			1	2	3	4	5	6
Quaternary	Holocene	clays and alluvial tills	+			+		
	Pleistocene	loess and loess loam	+		+			
		clays and marginal lake silts	+			+	+	
		clays and Elbląg silts	+	+		+	+	
		glacial tills	+					
Tertiary	Pliocene	clays (Gozdnica series)	+	+	+			
	Mio-pliocene	Poznań clays	+	+	+	+	+	+
		land clays	+			+	+	
	Miocene	marine clays	+			+	+	+
	Oligocene	septarian clays	+			+	+	
	Eocene-Oligocene	clay-slates of the Carpathian flysch	+	+		+		
Cretaceous		Cretaceous clays and clay--slates	+					
Jurassic	Dogger	Dogger clays (ore-bearing)	+			+	+	
	Liassic	Liassic clays	+	+		+	+	
Triassic	Keuper-Rhaetian	Keuper and Rhaetian clays	+	+		+	+	+
Permian		clays	+	+				
Carboniferous		clays and clay-slates	+	+	+	+		

(1-3) - thick products: 1 - full brick, 2 - building clinker, 3 - road clinker;
4 - hollow products; 5 - thin products; 6 - roof products

The most promising, as regards the possibilities of identification of deposits of this type, are: Miocene-Pliocene clays (50.7 % of prognostic resources), Miocene marine clays (21.1 %) and Quaternary clays and marginal lake silts (16.9 %). The remaining ones are: clay-silts of the Carpathian flysch (4.2 %) and also Dogger clays (3.9 %), Liassic clays (1.9 %) and Triassic clays (1.3 %).

Fig. 6. 1 Building ceramics raw materials resources and output in Poland in 1989-99



In voivodeships where there is a deficit of reserves compared with the demand and there are difficulties in increasing the reserves, the most important will be clays and marginal lake silts. Their prognostic resources amount there to 56.2 % and are almost twice as big as the prognostic resources of the Miocene-Pliocene clays (which rank second). Clay materials stored on dumps during exploitation of lignite, hard coal, sulfur, siderites and refractory clays so far hardly utilized also deserve mentioning.

There is no turnover of building ceramics raw materials in the international market although exports and imports of end-use ceramics products exist in Poland. Germany and Czech Republic are the main trade partners for Poland. In 1999 exports of the thick and thin products amounted to 11 thousand tons worth PLN 4,582 thousand and imports 404.3 thousand tons worth PLN 95,138. Exports of the roof products amounted to 76.8 thousand tons worth PLN 52,933 thousand and imports 105.48 thousand tons worth PLN 78,270 thousand. The negative exports-imports balance has increased for three years and in 1999 it amounted to almost PLN 116 thousand. For the last five years imports of the thin and thick products have increased fifteen times and imports of the roof products - several times. Also exports of the thick and thin products have systematically decreased for four years.

7. CERAMIC CLAYS

Two types of ceramic clays are distinguished as regards technology, i.e. colour of the ceramic body after burning - whiteware and stoneware clays.

The **whiteware clays** occur only in the Sudetes (Plate 7), mainly in the Cretaceous formations in the north-Sudetic basin as kaolinite clays measures between sandstones or a binding agent of the slightly compact sandstones and in the Tertiary formations, where they accompany lignite in the Turów deposit.

The resources of this raw material amount to 58.5 million tons. Lately small quantities have been exploited only from lignite deposit Turów and the output amounted to 13.04 tons in 1999.

The resources of whiteware ceramic clay (for faience and semi-vitreous China-ware), the state of their identification and management, are presented in Table 7.1.

Table 7.1 Whiteware ceramic clays (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**6**	**58.47**	**2.56**	**55.91**	**0.05**	**2.27**
including reserves of exploited deposits						
Total	1	-	-	-	-	-
including resources of not exploited deposits						
Total	3	57.91	2.02	55.89	-	2.03
1. Exploration	1	2.02	2.02	-	-	2.03
2. Prospecting	2	55.89	-	55.89	-	-
including abandoned deposits						
Total	2	0.55	0.53	0.02	0.05	0.25

The **stoneware clay** deposits occur in the Sudetes where they accompany whiteware clays in Cretaceous sediments in the north-Sudetic basin and in Tertiary sediments. Furthermore, the raw material deposits occur in the Silesian-Cracow (Rhaetic and Liassic) and also in the Holy Cross Mountain (Roethian, Rhaetic and Liassic) regions.The resources being explored in 22 deposits amount to about 83.9 million tons, of which 14 % occurs in six deposits being exploited. The ceramic clay output amounted to 167.5 thousand tons of stoneware clays in 1999.

The resources of the stoneware clays, the state of their identification and management are shown in Table 7.2.

Table 7.2 Stoneware ceramic clays (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**22**	**83.87**	**30.64**	**53.23**	**15.94**	**9.85**
including reserves of exploited deposits						
Total	6	11.84	11.03	0.81	5.14	9.85
including resources of not exploited deposits						
Total	10	63.57	12.67	50.90	8.40	-
1. Exploration	5	15.92	12.67	3.25	2.30	-
2. Prospecting	5	47.66	-	47.66	6.11	-
including abandoned deposits						
Total	6	8.47	6.95	1.52	2.39	-

8. CHALK

Under the name chalk we understand two types of deposits that occur in Poland: Cretaceous chalk and lacustrine chalk. They differ in chemical and petrographic composition, origin and practical utilisation. The Cretaceous chalk is utilized in the rubber, paper, chemical, pigment and cement industries, and lacustrine chalk (accompanying mainly calcareous gyttja) is utilized as a calcareous fertilizer in agriculture.

The Cretaceous chalk is a calcareous, slightly coherent and porous rock. Chalk limestones similar to chalk occur in the Chełm region in eastern Poland. They are used in the cement production and discussed in the chapter about limestones and marles for cement and lime production.

Glacial ice sheets of Cretaceous chalk occur in 16 deposits in eastern and north-eastern Poland (Plate 6). These deposits are 7 m to 16 m thick and the overburden thickness reaches 15 m. In 1999, the exploitation was conducted in five deposits. The Cretaceous chalk is utilized in the rubber, paper, chemical and pigment industries.

Lacustrine chalk (lacustrine limestone, lacustrine lime) occurs in northern and central Poland. It is a quaternary calcareous sediment of stagnant waters, often with an admixture of clay minerals and detritus. In the lacustrine chalk, overburden peat often occurs. This chalk (accompanying mainly calcareous gyttja) is utilized as a calcareous fertilizer in agriculture.

The state of chalk resources and their identification and management are presented in Table 8.1.

The output amounted to 2,178 thousand tons in 1999 (Fig. 8.1).

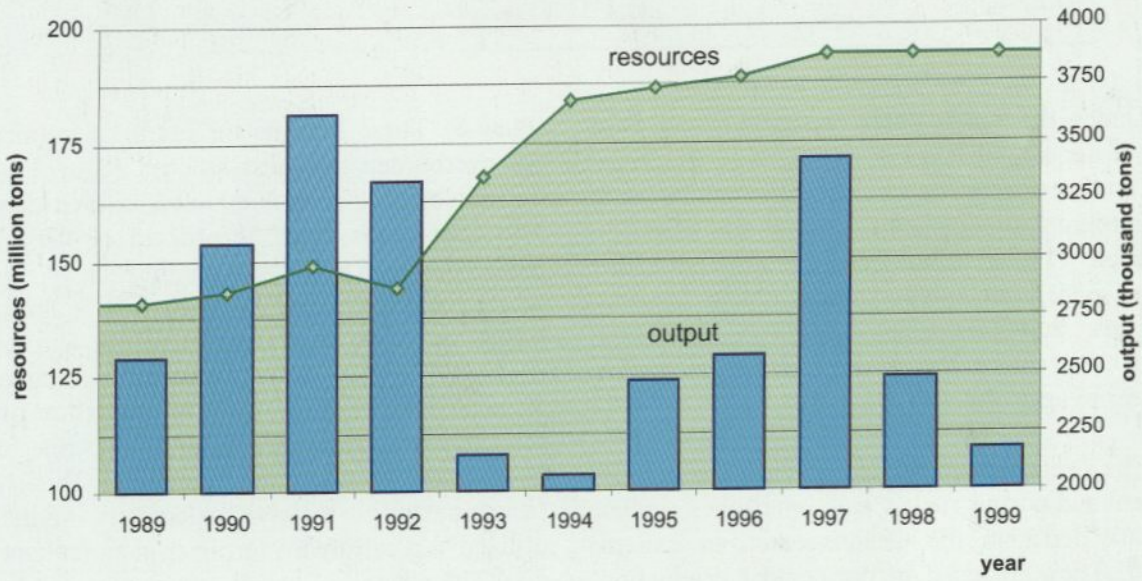
Table 8.1 Chalk (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**177**	**194.19**	**101.94**	**92.25**	**13.04**	**18.01**
including reserves of exploited deposits						
Total	60	48.50	30.31	18.19	12.86	14.39
including resources of not exploited deposits						
Total	82	124.74	55.84	68.90	0.15	3.10
1. Exploration	53	72.53	55.84	16.69	-	3.10
2. Prospecting	29	52.21	-	52.21	0.15	-
including abandoned deposits						
Total	34	20.95	15.79	5.16	0.02	0.52

The chalk imports amounted to 11.1 thousand tons in 1999.

The identified chalk resources and the possibility of identification of new lacustrine chalk deposits (mainly in northern Poland) and Cretaceous chalk (in the southern east) allow for increasing the output of this raw material.

Fig. 8. 1 Chalk resources and output in Poland in 1989-99



9. CLAY RAW MATERIALS FOR CEMENT PRODUCTION

Clay raw materials used for correction of the cement kiln charge, occur commonly throughout country. Their resources have been explored mainly in southern and south-eastern Poland, where the cement industry is located.

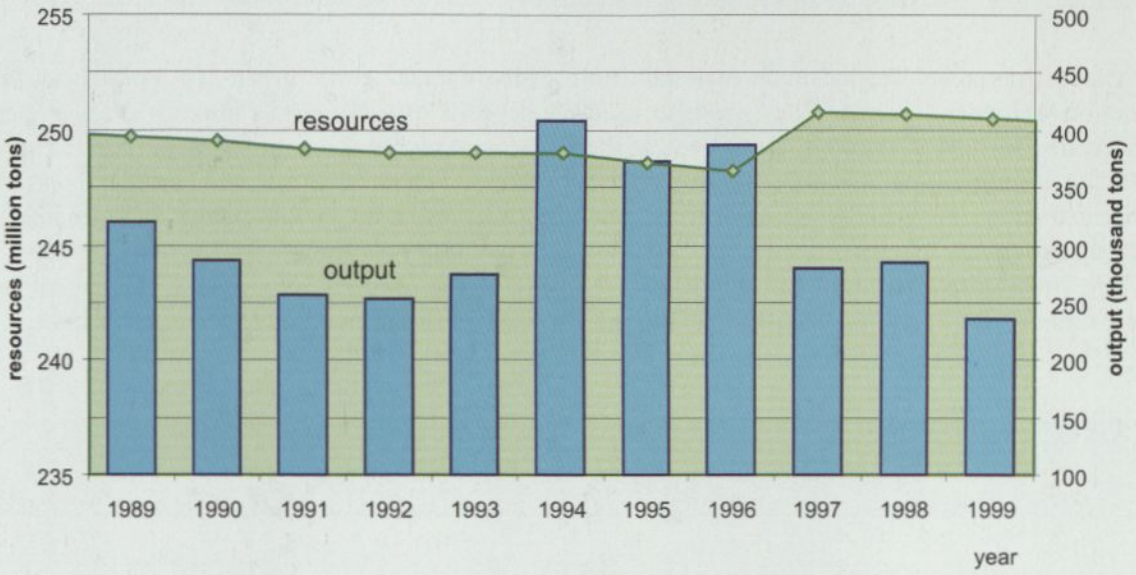
The state of their identification and management is shown in Table 9.1.

The output amounted to 235 thousand tons in 1999.

Table 9.1 Clay raw materials for cement production (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**24**	**250.44**	**212.21**	**38.23**	**13.71**	**26.94**
including reserves of exploited deposits						
Total	2	31.44	31.44	-	1.97	26.72
including resources of not exploited deposits						
Total	16	136.34	98.11	38.23	2.25	0.19
1. Exploration	14	103.32	98.11	5.21	2.25	0.19
2. Prospecting	2	33.02	-	33.02	-	-
including abandoned deposits						
Total	6	82.67	82.67	-	9.49	0.02

Fig. 9. 1 Resources and output of clay raw materials for cement production in Poland in 1989-99



10. CLAY RAW MATERIALS FOR LIGHTWEIGHT AGGREGATE PRODUCTION

Clay raw materials occurring in many deposits in the whole country are suitable for lightweight aggregate production. The explored deposits intended for this use lie mainly in northern Poland (Gdańsk region) and in the eastern part of Poland (Siedlce, Lublin and Zamość).

The resources of clay raw material for lightweight aggregate production amount to 193.48 million m^3 which is equivalent to 387 million tons.

The output of the considered raw materials from two deposits amounted to 153 thousand m^3 (306 thousand tons) in 1999.

Table 10.1 Clay raw materials for lightweight aggregate production (million m^3)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**48**	**193.48**	**47.99**	**145.49**	**4.60**	**5.16**
including reserves of exploited deposits						
Total	3	23.36	23.36	-	1.28	5.16
including resources of not exploited deposits						
Total	43	169.44	23.95	145.49	3.32	-
1. Exploration	10	28.98	23.95	5.03	0.06	-
2. Prospecting	33	140.46	-	140.46	3.26	-
including abandoned deposits						
Total	2	0.68	0.68	-	-	-

11. CLAY RAW MATERIALS FOR PRODUCTION OF MINERAL PAINTS

Mineral pigments are the main materials for production of mineral paints. They are also used for oil paints, varnishes, enamels, putties etc. In the production of mineral paints chalk, barite, gypsum and burnt lime are also used as mineral fillers and weighting agents.

The most important mineral pigments are: ochre, umbra, terra di Siena, iron minimum, browns and earth green. In Poland so far two deposits of ochre, argils and ochre claystones have been explored in central Poland near Kielce (Plate 4). In these deposits, in argilic measures of Rhaetic-Liassic, ochres make lens accumulations. The resources amount to 578 thousand tons.

The imports of mineral pigments (mainly from China) amounted to 539 tons in 1999.

12. COAL BED METHANE (CBM)

Exploitation of coal bed methane (CBM) is considered to be a method of extracting gas from non-conventional sources.

The state of identification of CBM resources is shown in Table 12.1.

Proven initial resources occur in 42 deposits in the Upper Silesian Coal Basin (Górnośląskie Zagłębie Węglowe (GZW)).

In the area of exploited coal deposits, the reserves extractable by methods of demethanization of mines are regarded as proven initial ones. In the remaining coal basins, i.e. the Lower Silesian Coal Basin (Dolnośląskie Zagłębie Węglowe (DZW)) and Lublin Coal Basin (Lubelskie Zagłębie Węglowe (LZW)) ones no fields of CBM reserves have been proved (Plate 1).

In the case of CBM the industrial (economic) reserves are determinated separately - as proven initial reserves from the parts of deposit, which will subjected to demethanization. For CBM fields, in the Upper Silesian Coal Basin (with industrial (economic) reserves calculated in the Project of deposit management) these reserves represent 80 % of the proven initial resources.

As regards fields of CBM being outside the exploited coal deposits, the resources possible for recovering are not defined because the quantity of recoverable methane will depended on the method of exploitation.

Therefore, we decided to present in the tables the resources separately for both kinds of areas. All we can say is that approximately only one-third of CBM resources occurring in the areas being outside the exploited coal deposits is comparable with the initial proven resources of CBM in the coal mines.

The methane output from the fields of proven initial resources amounted to 269 million m^3 in 1999. The quantity of methane, called emission from ventilation system, emitted in 1999 to the atmosphere from the above-mentioned coal deposits amounted to 194 million m^3. These data can be useful for estimating atmospheric pollution by methane from mine ventilation. However, for full estimation of, the atmospheric pollution also the mines in which methane was detected but the reserves of the gas have not been proved should be taken into consideration.

Table 12.1 Coal bed methane (million m^3)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**42**	**89,416.52**	**8,127.97**	**81,288.55**	**45,289.84**	**2,767.40**
including: Resources in the hard coal exploitation regions	25 *	17,642.47	7,271.67	10,370.80	24,494.61	1,597.84
Resources outside the hard coal exploitation regions	21 *	71,774.05	856.30	70,917.75	20,795.23	1,169.56

* in four deposits the raw material occurs within and outside the area of coal exploitation

The highest potential of CBM is found in the Upper Silesian Coal where perspective resources were estimated at about 350 billion m^3 in 1991. The perspectives are considerably worse in the Lower Silesian Coal Basin where the perspective resources amounted to about 5 billion m^3. In the Lublin Coal Basin, the possibility of CBM occurring is not excluded, but insufficient information does not allow quantitative estimation.

Estimation of the possibility of methane occurrence relates to the zones with increased methane content defined by the limit of 3rd class of methane hazard (over 4.5 m^3 per ton of crude coal matter (csw)). The zones pertain to the beds of thickness exceeding 0.3 m lying at a depth 1,600 m in the Upper Silesian Coal Basin and of 1,000 m in the Lower Silesian Coal Basin.

13. COPPER ORES

Copper ores of industrial importance occur in Lower Silesia (in the northern-Sudetic syncline) and in the pre-Sudetic monocline (Plate 3). Copper mineralization is connected with Zechstein Kupferschiefer and with upperlying sandstones and underlying dolomites.

The main deposits under exploitation lie in the monocline near Lubin. The resources of copper ores have decreased since 1971 because of their exploitation and the change of evaluation criteria. The decrease of the resources has been considerable in the recent years due to the fact that all ores occurring below the depth of 1,250 m have been excluded from the country's balance. The resources amounted to 2,542 million tons of ore in 1999 with a content of copper of 49.8 million tons (Table 13.1).

Over 64 % of the total resources (1,624 million tons) occur in deposits in exploitation. The resources occur mainly at a depth from 1,000 m to 1,250 m. Separate managing of these deposits, will be troublesome. The parameters of the ores occurring below 1,250 m are almost the same as those being actually exploited. They have been classified as potentially economic ores because of the high temperature of the massif and therefore difficult conditions and high costs of exploitation.

The economic reserves of the exploited deposits amount to 781 million tons of ore and 16.6 million tons of copper.

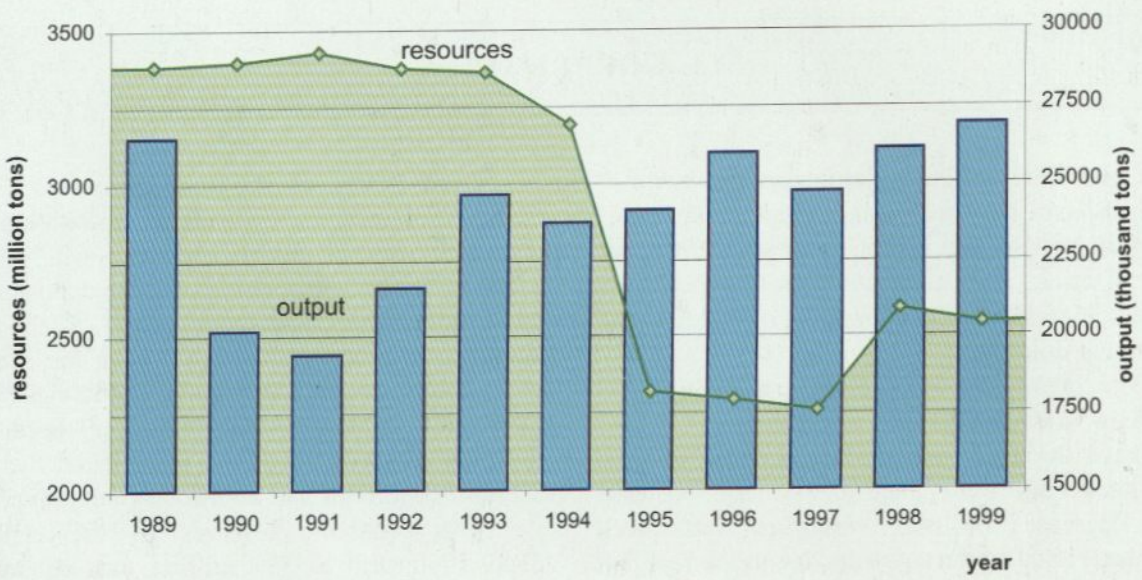
The output (Fig. 13.1) of copper ores amounted to 26.9 million tons of the ore, of which metallic copper amounted to 520 thousand tons in 1999.

Table 13.1 Copper ores (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**14**	*** 2,542.02**	**2,472.37**	**69.65**	**630.50**	**781.09**
		** *49.84*	*48.97*	*0.88*	*10.71*	*16.58*
including reserves of exploited deposits						
Total	5	1,623.78	1,623.78	-	39.08	781.09
		30.98	*30.98*	-	*0.50*	*16.58*
including resources of not exploited deposits						
Total	7	847.56	812.60	34.96	553.61	-
		18.08	*17.56*	*0.52*	*9.94*	-
1. Exploration	4	812.60	812.60	-	45.44	-
		17.56	*17.56*	-	*0.59*	-
2. Prospecting	3	34.96	-	34.96	508.17	-
		0.52	-	*0.52*	*9.35*	-
including abandoned deposits						
Total	2	70.68	35.99	34.69	37.81	-
		0.79	*0.43*	*0.36*	*0.27*	-

* ore, ** *metallic copper*

Fig. 13. 1 Copper ores resources and output in Poland in 1989-99



A considerable part of copper production from the domestic deposits is destined to exports (Table 13.2). In 1999, exports of copper amounted to 247.9 thousand tons, mainly electrolytic - cathode, wirebars, ingots and also alloys and copper compounds.

Table 13.2 Directions of Polish imports and exports of copper

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**7.85**	**55,736**		**Total**	**247.95**	**1,519,142**
1	Germany	3.97	37,295	1	France	62.52	398,995
2	Sweden	0.65	4,975	2	Germany	48.39	280,371
3	Russia	0.84	2,678	3	China	35.01	202,764
4	Belgium	0.20	1,592	4	Sweden	22.09	138,903
5	Romania	0.26	1,517	5	Austria	21.97	136,115
6	Moldova	0.33	1,468	6	United Kingdom,the	15.42	106,651
7	Finland	0.47	1,134	7	Hungary	13.86	87,629
8	Italy	0.05	832	8	Italy	9.50	52,232
9	Uzbekistan	0.35	595	9	Czech Rep.	7.11	38,989
10	France	0.06	592	10	Netherlands, the	4.96	30,994
11	Lithuania	0.12	545	11	USA, the	3.60	25,046
12	Austria	0.01	313	12	Finland	1.00	6,829
13	Kazakhstan	0.12	292	13	Ukraine	0.76	4,259
14	United Kingdom,the	0.02	275	14	Slovakia	0.69	3,996
15	Belarus	0.09	259	15	Belgium	0.49	1,932
16	Netherlands, the	0.02	243	16	Belarus	0.20	1,391
17	Unidentified country	0.07	216	17	Canada	0.11	654

Extracted from copper ores are following elements: Ag, As, Au, Ni, Pb, Re, Se, Zn. Silver extraction is the most important in Polish economy. Over 79 % is exported. The production of extracted metals in 1999 amounted to:

- metallic silver: 1,092.64 tons;
- crude lead: 13,800 tons;
- metallic selenium: 66.5 tons;
- nickel (nickel sulfate): 1,722 tons;
- metallic gold: 0.490 tons; and
- slime Pt-Pd: 0.070 tons.

14. CRUDE OIL

In Poland, oil fields occur in the Polish Lowland (Niż Polski), the Carpathian Foredeep (Zapadlisko Przedkarpackie), the Carpathians (Karpaty), and on the Baltic Sea (Morze Bałtyckie) (Plate 1). In this publication only the onshore resources are considered.

The Polish Lowland has become the most important petroliferous area in this country since BMB oil field was explored in 1996, the recources of which are more than two times as much as the all Poland resources at the time. The Polish Lowland accounts for 90.7 % of the national resources while the Carpathian Foredeep for - 5 % and the Carpathians for 4.3 % only. The initial proven oil resources of oil and oil condensate, as well as the state of their identification and management are shown in Table 14.1.

In the Polish Lowland, oil fields occur in the Permian, Carboniferous and Cambrian rocks. They yield a medium paraffin (4.3 - 7.4 %) oil with sulfur content exceeding 1 % and density ranging from 0.857 g/cm^3 to 0.870 g/cm^3.

In the regions being considered, beside oil fields, there are also oil condensate fields, containing 100 g of condensate per 1 cm^3 of gas.

In the Carpathian Foredeep, oil fields occur in the Tertiary sediments and the Mesozoic sediments of a platform type (mainly Jurassic carbonate

rocks, rarely in Cretaceous sandstones) which mostly underlie the impermeable Miocene clay sediments. They are mainly bedded fields, stratigraphically closed (either lithological or tectonic). In this region, it is light and medium weight oil (it is density being 0.811-0.846 g/cm^3). The oil contains 2.32 - 9.37 % paraffin and the content of sulfur ranges, on the average, from 0.45 to 0.85 %.

In the Carpathians oil fields, there occur in several tectonic units, including: the Magura, Dukla-Michów, sub-Silesian, Silesian and Skole one, but most of them lie in the Silesian unit. They are mainly structural fields, seldom structural-lithological ones, mostly of a bedded type.

The Carpathian oil is of methane type. Its density ranges from 0.750 to 0.943 g/cm3. It is free from sulfur, mostly a paraffin oil containing 3.5 - 7 % of paraffin. The reserves are small and they depend on the quantity and type of the structures in which they occur. Initially, in place resources mainly range from a few to over 400 thousand tons. Many years of the exploitation, has exhausted the reserves in this region.

From among ninety-five oil fields eighty-three are under exploitation and their resources amount to 97 % of the total Polish onshore reserves.

The intrinsically economic onshore oil resources of Poland (without the Polish economic zone of the Baltic Sea) amounted to about 14,038 thousands tons in 1999, with the total economic reserves, amounting to 10,931 thousand tons.

The production (Fig. 14.1) of oil and condensate amounted to 187 thousand tons in 1999. The production of oil from the Carpathian oil fields amounted to 22.7 % of the total Polish oil production, that from the Carpathian Foredeep to 14.2 %, and that from the Polish Lowland to 63 %.

Fig. 14. 1 Crude oil resources and output in Poland in 1989-99

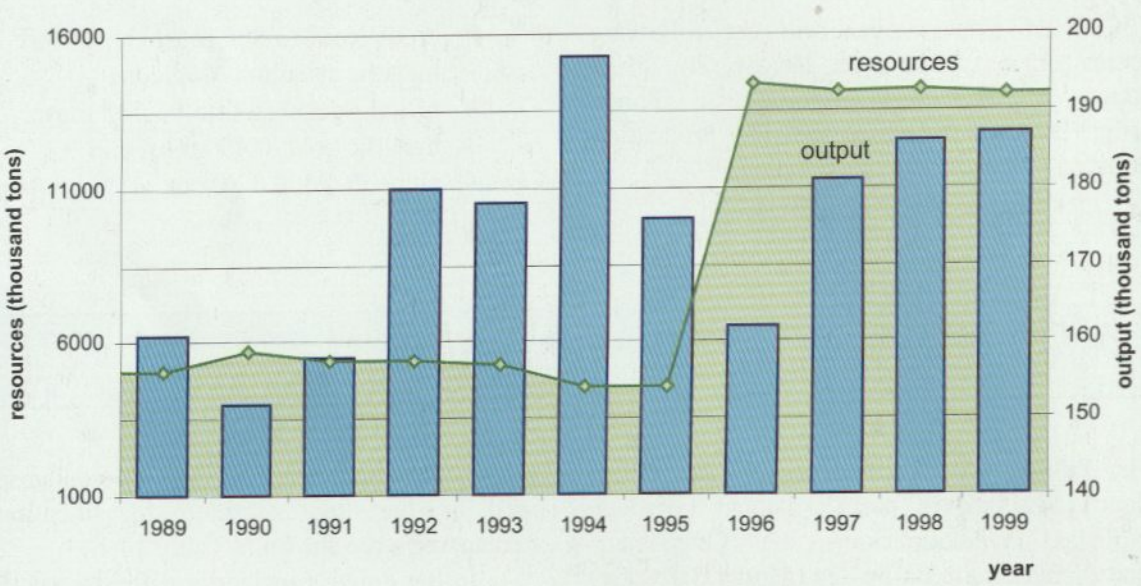


Table 14.1 Crude oil (thousand tons)

Specification	Number of fields	Extractable Reserves / resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	* **95**	**14,038**	**7,445**	**6,593**	**427**	**10,931**
	** **89**	**12,499**	**7,378**	**5,121**	**427**	**10,818**
	*** **7**	**1,539**	**67**	**1,472**	**-**	**113**
including reserves of exploited fields						
Total	83	13,588	7,394	6,193	102	10,931
	81	12,207	7,361	4,846	102	10,818
	4	1,381	34	1,347	-	113
the Carpathians	41	587	322	265	80	280
	42	585	321	264	80	280
	1	2	-	2	-	-
the Carpathian Foredeep	9	585	414	171	12	163
	8	574	403	171	12	163
	1	10	10	-	-	-
Polish Lowland	33	12,417	6,659	5,757	10	10,487
	31	11,048	6,636	4,412	10	10,374
	2	1,369	23	1,346	-	113
including resources of not exploited fields						
Total	6	291	50	241	325	-
	3	133	17	116	325	-
	3	158	33	125	-	-
the Carpathians	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
the Carpathian Foredeep	2	116	-	116	325	-
	2	116	-	116	325	-
	-	0	-	-	-	-
Polish Lowland	4	175	50	125	-	-
	1	17	17	-	-	-
	3	158	33	125	-	-
including abandoned fields						
Total	6	159	1	158	-	-
	5	159	1	158	-	-
	-	-	-	-	-	-
the Carpathians	1	9	-	9	-	-
	1	9	-	9	-	-
	-	-	-	-	-	-
the Carpathian Foredeep	-	-	-	-	-	-
	-	-	-	-	-	-
	-	-	-	-	-	-
Polish Lowland	5	151	1	150	-	-
	4	151	1	150	-	-
	-	-	-	-	-	-

* total, ** crude oil, *** oil condensate

Table 14.2 Directions of Polish import of crude oil

	Country	thousand tons	thousand PLN
	Total	**15,272.03**	**7,313,490**
1	Russia	13,554.50	6,325,157
2	Norway	708.28	424,894
3	United Kingtom, the	403.14	221,874
4	Lithuania	228.61	128,274
5	Kazakhstan	232.52	124,020
6	Libya	68.84	41,112
7	Ukraine	30.48	20,604
8	Slovakia	23.83	14,085
9	Czech Rep.	21.78	13,362
10	Italy	0.06	35

Imports of oil amounted to 15,272 thousand tons in 1999. The directions and quantities of imports are shown in Table 15.2. Over 88 % of imported oil came from Russia, 4.6 % from Norway and 2.6 % from the United Kingdom. Imports of oil products (fuels, paraffin, oils, mineral jelly, waxes, etc.) amounted to 4,116 thousand tons while exports to 1,993 thousand tons (Table 14.3).

The estimate of perspective resources shows that the possibility of an increase of the oil reserves is limited. Such an increase is possible mainly in the Polish Lowland, on the Baltic Sea (in the Polish economic zone) and in the Carpathians where exploration is actually under way. According to the estimate of the Polish Geological Institute made in 1991, the prognostic oil resources in Poland (except for the Baltic Sea) totalled 72.5 million tons, including 46 million tons in the Polish Lowland, 17.5 million tons in the Carpathians and 9 million tons in the Carpathian Foredeep.

Table 14.3 Directions of Polish imports and exports of oil products and natural bitumens

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Oil products							
	Total	**4,116.18**	**3,121,747**		**Total**	**1,992,86**	**748,293**
1	Sweden	870.82	667,680	1	Denmark	773.66	230.539
2	Germany	766.47	665,654	2	Czech Rep.	261.41	127,668
3	Russia	750.43	406,168	3	Norway	248.13	78,617
4	Lithuania	430.39	265,734	4	Germany	210.37	66,488
5	Finland	327.55	247,250	5	Netherlands, the	169.77	50,903
6	Czech Rep.	188.22	142,646	6	Tank	87.53	39,785
7	Slovakia	141.71	118,067	7	Sweden	71.73	26,214
8	United Kingdom, the	112.24	112,520	8	Ukraine	4.95	15,994
9	Netherlands, the	86.62	89,428	9	Austria	11.72	12,634
10	Belgium	65.95	77,320	10	Bahamas	24.12	11,551
11	Belarus	138.29	77,237	11	Malta	16.80	8,771
12	Denmark	91.30	75,838	12	Hungary	7.34	8,767
13	France	39.59	58,640	13	Slovenia	3.59	6,653
14	Norway	58.23	49,224	14	United Kingdom, the	10.82	6,572
15	Austria	6.35	21,273	15	Lithuania	3.26	5,592
16	Hungary	7.85	12,551	16	Slovakia	13.38	5,549
17	USA, the	5.84	6,806	17	Unidentified country	8.80	5,316
18	Switzerland	5.06	6,296	18	Cyprus	8.94	5,202
19	Italy	1.74	5,426	19	Liberia	9.01	4,231
20	Ukraine	10.12	4,130	20	Panama	8.35	3,316
21	Cyprus	5.12	3,807	21	Belarus	0.93	3,193
22	China	1.36	3,080	22	Russia	1.76	2,738
23	Saudi Arabia	0.86	1,195	23	Greece	4.72	2,378
24	Slovenia	1.16	1,136	24	Georgia	4.89	1,981

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
25	Chile	0.85	930	25	USA, the	2.72	1,752
26	Kazakhstan	1.90	813	26	Neth. Antilles	5.38	1,371
27	Canada	0.01	151	27	Romania	0.70	1,152
28	Spain	0.01	147	28	Algeria	0.69	975
29	United Arab Emirates,the	0.03	105	29	France	0.61	951
30	South Korea	0.01	99	30	Italy	1.64	914
31	Japan	0.02	97	31	Moldova	0.21	764
32	South Africa	0.01	80	32	Marshall Islands	1.59	761
33	Estonia	0.02	63	33	Switzerland	0.49	647
34	Unidentified country	0.03	44	34	Bulgaria	0.27	541
35	Brazil	0.01	32	35	Singapore	1.07	537
36	Ireland	0.00	26	36	Taiwan	0.17	520
Natural bitumines							
	Total	**0.16**	**287**		**Total**	**9.28**	**4,375**
1	Czech Rep.	0.12	110	1	Germany	6.10	3,014
2	USA	0.01	60	2	Russia	2.47	848

15. DIATOMACEOUS ROCK

Diatomite is a silica-argillaceous, light-weight, porous rock of strong sorptional properties, which makes it suitable for use as support filling agent, purifying material, filtering material and insulating agent in the chemical, food and building industries.

In Poland as yet no typical diatomite deposits have been discovered, however, in the Carpathians (Plate 4), within the Krosno measures, diatomaceous rock occurs in the Leszczawka region with an average SiO_2 content of 72 %, apparent density - 1.42 g/cm^3, bulk density - 0.49-1.28 g/cm^3 and porosity - 28.5 %.

The resources and reserves of diatomaceous rock and state of their identification and management are presented in Table 15.1.

Table 15.1 Diatomites (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**4**	**10.03**	**3.29**	**6.74**	**2.74**	**0.32**
including reserves of exploited deposits						
Total	2	1.04	0.45	0.59	-	0.32
including abandoned deposits						
Total	2	8.99	2.84	6.15	2.74	-

The explored resources amount to 10.03 million tons. Two mining plants operate in the Leszczawka region. The output of the diatomaceous rock was 1.24 thousand tons in 1999.

The actually used enrichment technology does not allow products of good quality to be extracted from diatomaceous rock, so their use is fairly limited (production of light-weight building

aggregates and carrier of plant protection agents). In this situation, import of high-quality diatomite is indispensable.

There are possibilities of increasing diatomaceous rock reserves, because the perspective reserves in the Leszczawka region amount to about 10 million tons. Considerably bigger perspectives of discovering diatomite deposits relate to menilite series of the Krosno measures in south-eastern Poland, in the Błażowa and Godów region, and also in the Dydynia-Krzywe region.

16. DIMENSION AND CRUSHED STONES

The group of dimension and crushed stones (in Poland they are named building and road stones) is commonly used in building, road and railway construction. In Poland, different types of magmatic, metamorphic and sedimentary rocks occur (Plate 6). Magmatic rock deposits comprise basalts, gabbros and diabases, granites, granodiorites and syenites, melaphyres, porphyries and keratophyres, and porphyric tuffs. Among metamorphic rock deposits are: amphibolites, gneisses, hornfelses, quartzites, schists, marbles and serpentinites. Sedimentary rock deposits include: dolomites, marls, limestones, gaizes (cherts), sandstones and conglomerates, as well as siliceous rocks (chalcedonites). The actual resource base of dimension and crushed stones in Poland amounts to 8,0 billion tons explored in 507 deposits (Table 16.1). Limestones from deposits recognized for the cement and lime industry as well as dolomite for the metalurgical and agriculture industries are not included here.

The variation of the reserves in the past twenty years indicated an intensive increase of resources owing to the identification of new deposits before 1981 when an increase of reserves from 5 to over 8 billion tons took place. Since 1982 the level of reserves of the above-mentioned raw materials has oscillated around 8 billion tons.

Table 16.1 Dimension and crushed stones (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**507**	**8,014.27**	**4,888.86**	**3,125.40**	**530.08**	**2,968.79**
including reserves of exploited deposits						
Total	203	3,871.53	3,042.80	828.73	126.90	2,887.35
including resources of not exploited deposits						
Total	157	3,665.11	1,469.20	2,195.91	382.21	81.44
1. Exploration	110	1,753.53	1,469.20	284.33	125.06	81.44
2. Prospecting	47	1,911.58	-	1,911.58	257.15	-
including abandoned deposits						
Total	147	477.62	376.86	100.76	20.96	-

Table 16.2 The resources and output of different types of dimension and crushed stones (million tons)

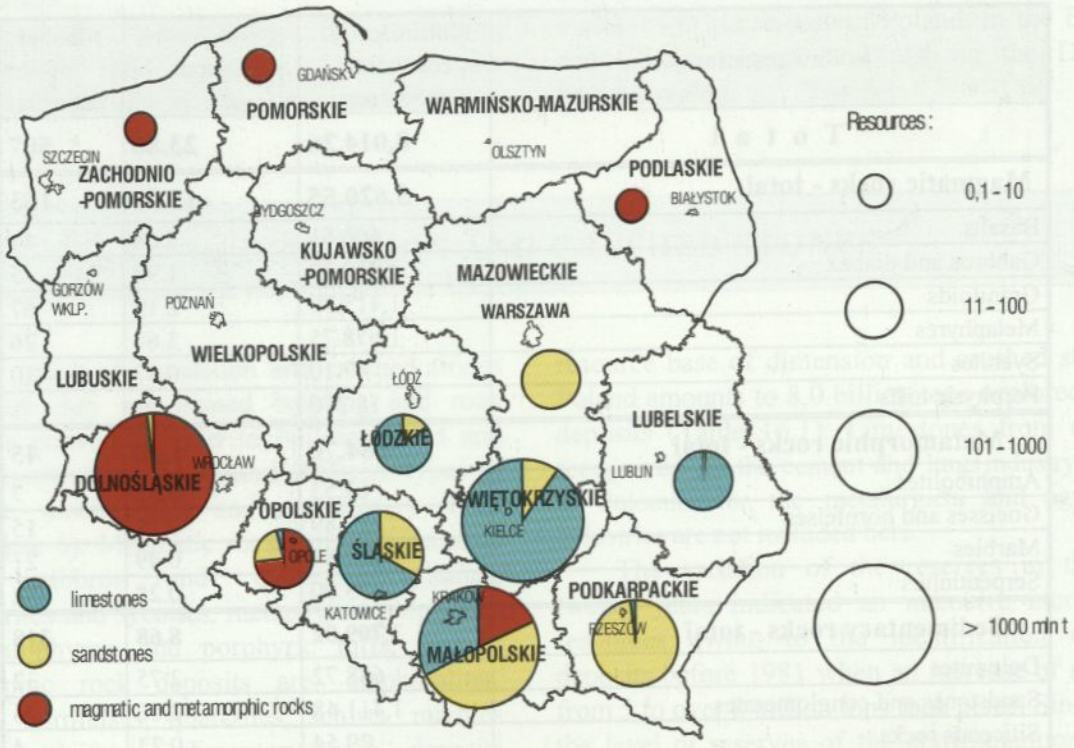
Raw material	Intrinsically eoconomic resources	Output	Number of deposits
T o t a l	**8,014.26**	**23.86**	*** 507**
Magmatic rocks - total	**3,620.55**	**13.98**	**153**
Basalts	600.61	5.68	44
Gabbros and diabaz	460.12	1.90	5
Granitoids	1,415.70	2.19	67
Melaphyres	1,078.75	3.64	26
Syenites	47.10	0.57	10
Porphyric tuffs	18 270	-	1
Metamorphic rocks - total	**684.70**	**1.20**	**45**
Amphibolites	62.53	0.32	7
Gneisses and hornfelses	123.89	0.11	15
Marbles	424.88	0.49	21
Serpentinites	73.90	0.28	2
Sedimentary rocks - total	**3,709.02**	**8.68**	**318**
Dolomites	688.72	2.75	32
Sandstones and conglomerates	1,411.48	2.06	176
Siliceous rocks	29.54	0.23	4
Limestones and marls	1,579.28	3.65	105
Menilite schiststs	32.61	0.20	1

* a total of 9 deposits contain two raw materials for manufacturing both dimension and crushed stones

The exploitation of dimension and crushed stones is conducted in 203 deposits whose reserves are almost 3.9 billion tons (above 48% of the total resources). In the resource balance of Poland additional 157 deposits suitable for management are noted whose total resources account to 3.7 billion tons. In 147 deposits the extraction was abandoned even though they still contain almost 0.5 billion tons of resources.

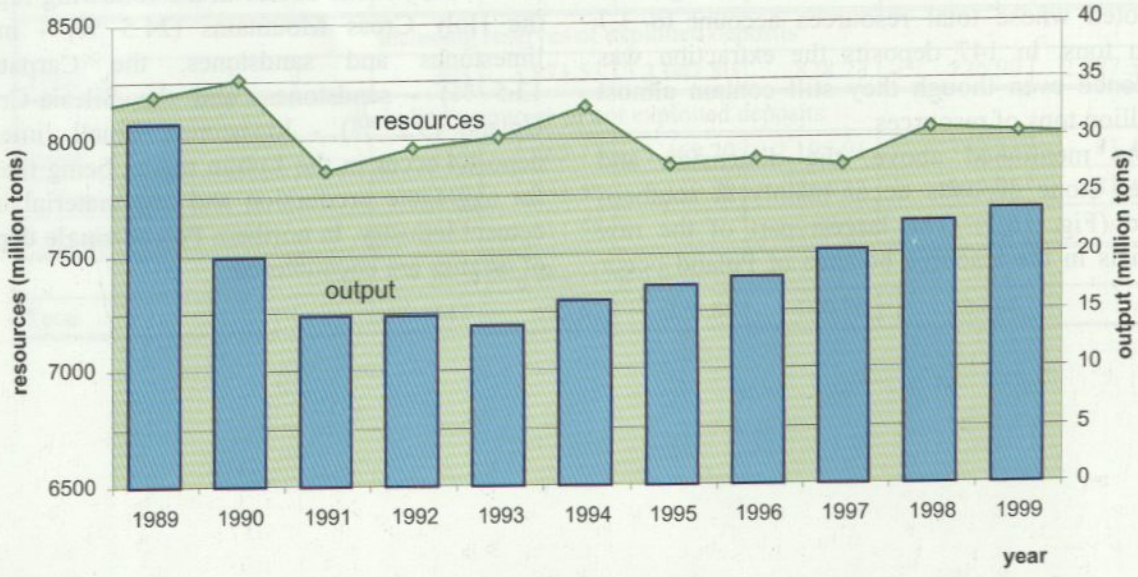
As mentioned above, the dimension and crushed stone deposits occur mainly in southern Poland (Fig. 16.1). The largest part of the raw materials in the resource balance of Poland occur in the Lower Silesia (nearly 52.5 % of resources), coresponding mainly magmatic and metamorphic rocks. The sedimentary rocks appear there only in small quantities. The remaining resources of sedimentary rocks occurr in the following regions: the Holy Cross Mountains (24.5 %) - mainly limestones and sandstones, the Carpathians 13.5 %) - sandstones, and the Silesia-Cracow Upland (9.2 %) - limestones. Small limestone deposits occur in the Lublin region being the base for aggregate production and raw material in the cement industry. In northern Poland single deposits of erratics are encountered.

Fig. 16.1 The distribution of resources and principal lithologic types of dimension and crushed stones in Poland



The output of dimension and crushed stone has considerably varied in the past decade. The maximum output was noted in 1989 (Fig. 16.2). These magnitudes show the management potential of this group of raw materials. The present level of exploitation, amounts to almost 23.9 million tons (1999).

Fig. 16. 2 Dimension and crushed stones resources and output in Poland in 1989-99



Some lithologic types of rocks are suitable for block stones (dimension) some only for aggregates (crushed stones). Those used for crushed stones include: basalts, amphibolites, diabases, gabbros, gneisses, quartzites, melaphyres, porphyries and keratophyres as well as serpentinites. The general rule is that block stones are extracted wherever it is possible. Mine wastes obtained after the extraction of blocks are used as crushed aggregates. Among sedimentary rocks making up the largest number of deposits, such as limestones and sandstones, only some are suitable for block extraction.

Table 16.3 Directions of Polish imports and exports of dimension and crushed stones

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Pitchers, slabs and curbs						
	Total	**0.80**	**313**		**Total**	**238.61**	**57,450**
1	Germany	0.40	114	1	Germany	234.50	55,784
2	Ukraine	0.34	99	2	Austria	1.63	593
3	Norway	0.01	34	3	Sweden	1.32	458
	Crushed stone						
	Total	**696.37**	**51,275**		**Total**	**134.91**	**5,376**
1	Sweden	287.60	13,118	1	Germany	133.11	4,867
2	Austria	26.09	10,254	2	Russia	0.61	152
3	Czech Rep.	55.02	8,890	3	Sweden	0.07	129
4	Germany	13.32	4,653	4	Czech Rep.	0.85	102
5	United Kingdom,the	131.56	4,571	5	Belgium	0.04	32
6	Norway	23.58	3,377	6	Ukraine	0.06	28
7	Ukraine	93.69	2,067	7	Canada	0.01	16
8	France	1.38	1,346	8	Slovakia	0.07	16
9	Slovakia	24.81	1,084	9	China	0.00	10
10	Belarus	37.90	803	10	Lithuania	0.04	9
11	Italy	0.97	639	11	Belarus	0.02	6
	Dimension stone						
	Total	**282.11**	**251,712**		**Total**	**89.86**	**74,962**
1	Italy	26.65	70,584	1	Germany	84.80	63,203
2	South Africa	86.15	57,622	2	Austria	1.65	3,116
3	Sweden	45.27	24,226	3	Moldova	0.18	1,297
4	Spain	11.96	17,268	4	Russia	0.44	1,152
5	India	11.69	11,580	5	Ukraine	0.42	886
6	Germany	8.54	8,753	6	Sweden	0.34	828
7	Belgium	3.64	7,600	7	Latvia	0.06	733
8	Finland	17.53	7,475	8	Netherlands, the	0.17	719
9	Norway	7.13	7,323	9	Czech Rep.	0.97	566
10	Brazil	6.33	6,905	10	Belarus	0.20	521
11	Czech Rep.	27.78	5,503	11	Estonia	0.03	465
12	Greece	1.83	4,278	12	Italy	0.03	286
13	France	2.91	3,924	13	France	0.08	259
14	Turkey	2.15	3,689	14	Hungary	0.02	172
15	Ukraine	10.81	3,595	15	Belgium	0.11	160
16	Portugal	3.05	2,287	16	Switzerland	0.13	149
17	China	1.20	2,003	17	Lithuania	0.11	116
18	Zimbabwe	1.80	1,847	18	Denmark	0.06	87
19	Austria	0.58	1,061	19	USA, the	0.01	70
20	Netherlands, the	1.32	754	20	Slovakia	0.03	59
21	Russia	1.37	745	21	Luxembourg	0.02	44

Crushed aggregates are generally high grade raw material of much better quality than natural aggregates. The quality of the aggregates depends on the type of raw material and its quality parameters in the deposits. Therefore, some of the raw materials are exploited on a huge scale exceeding the potential of the resources base of Poland. Basalts are good example of such raw materials.

17. DOLOMITES

Dolomites are used in the metallurgical industry as fluxes, in the agriculture industry as magnesium-calcium mineral fertilizer, in the ceramic industry and also as building and road materials (crushed aggregate, grits etc.).

Dolomite deposits suitable for the metallurgical industry occur mainly in the Katowice voivodeship (Plate 6). They are bedded Tertiary (Middle and Lower Muschelkalk) or Middle Devonian deposits.

Dolomites for the ceramic industry occur in the Lower Silesia (Dolny Śląsk) (Plate 6), where they form lentil deposits in metamorphic shales. Two deposits exist in this region: Rędziny and Ołdrzychowice-Romanowo. The dolomites from the latter deposit are of excellent quality, but in spite of this they are used for production of grits. The resources of dolomites in these two deposits are classified as road and building stone (dimension and crushed) resources.

The bedded Devonian dolomites are quite numerous in the Holy Cross Mountain region. The majority of the dolomites cannot be exploited because they occur in ecologically protected areas (landscape parks and ground water accumulation regions).

The dolomite deposit resources and the state of their identification and management are presented in Table 17.1.

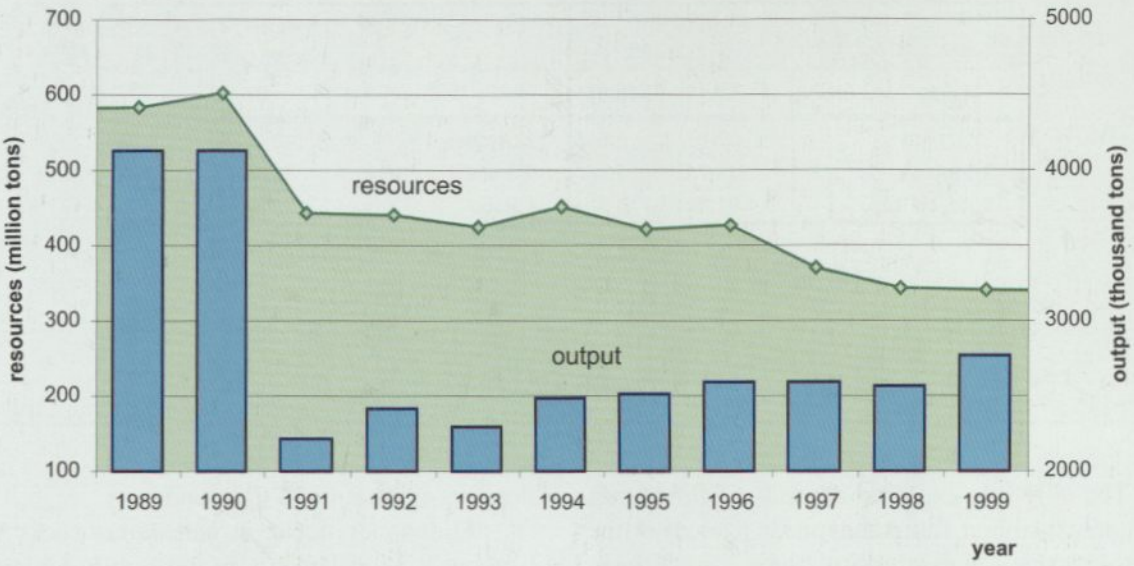
Table 17.1 Dolomites (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**10**	**341.28**	**230.77**	**110.51**	**10.39**	**156.46**
including reserves of exploited deposits						
Total	4	172.00	130.21	41.79	9.84	144.74
including resources of not exploited deposits						
Total	4	116.91	72.41	44.50	0.55	-
1. Exploration	3	86.22	72.41	13.81	0.55	-
2. Prospecting	1	30.70	-	30.70	-	-
including abandoned deposits						
Total	2	52.36	28.14	24.22	-	11.72

The resources amount to 341 million tons. Over 50.4 % of these resources occur in four deposits in exploitation. Four explored deposits remain to be managed, as well as numerous prospective areas - mainly in the Silesian-Cracow region and several in the Holy Cross Mountains. The output of dolomite for the metallurgical and agricultural industries amounted to 2,772 thousand tons in 1999 (Fig. 17.1).

In spite of the fact that the domestic resources could be exploited, the demand for dolomite flour (of extra high quality) is satisfied by imports. Imports amounted to 106 thousand tons while exports only to 2.1 thousand tons in 1999.

Fig. 17. 1 Dolomite resources and output in Poland in 1989-99



18. FELDSPAR RAW MATERIALS

The deposits of feldspar raw materials occur in the Lower Silesia (Dolny Śląsk) and the Silesia-Cracow region (Plate 6). They consist of feldspar and quartzic-feldspar rocks rich in alkalies. The rocks are leucogranites in the Lower Silesia near Strzeblów and Kopaniec, porphyric granites in the Jelenia Góra basin and quartz-feldspar as raw material accompanying the kaolin deposit. Other rocks occur in the Silesia-Cracow region, i.e. potassium trachyte and Kwaczalska arkose.

The intrinsically economic resources of feldspar raw materials amount to 88.9 million tons.

Actually, two deposits are in exploitation and their resources amount to 13.3 million tons. The deposits are leucogranite (near Strzeblów) and weathering waste of the Karkonosze Mountain porphyric granites (near Jelenia Góra). Five deposits with 75.6 million tons of total resources remain in the group of not exploited deposits.

The states of identification and management are presented in Table 18.1.

The output of the feldspar raw material amounted to only 9 thousand tons in 1999.

Imports of feldspar raw material amounted in 1999 to 57.4 thousand tons worth PLN 18,915 thousand.

Table 18.1 Feldspar raw materials (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**7**	**88.90**	**19.40**	**69.50**	**13.18**	**3.41**
including reserves of exploited deposits						
Total	2	13.33	13.33	-	-	3.41
including resources of not exploited deposits						
Total	5	75.57	6.07	69.50	13.18	-
1. Exploration	2	14.19	6.07	8.12	-	-
2. Prospecting	3	61.38	-	61.38	13.18	-

Table 18.2 Directions of Polish import of feldspar raw materials

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**57.38**	**18,915**				
1	Norway	12.83	6,468	4	Sweden	4.87	1,329
2	Finland	15.74	5,586	5	Spain	2.25	1,021
3	Czech Rep.	21.22	4,235	6	Italy	0.22	132

19. FLINTSTONES

The only two explored deposits of flintstones (ornamental ribbon flintstones) near Kielce (in the Świętokrzyskie voivodeship) have not been exploited so far. The total resources of these deposits amount to 28 thousand tons.

Flintstones occur in calcareous rocks in the Cracow-Wieluń Upland, in the Lublin Upland and in the surroundings of the Holy Cross Mountains

20. FOUNDRY SANDS

Foundry sands show a high temperature sintering point and are the basic material for making moulding and core compounds which are used for making casts from metal alloys. The sands consist of a sand matrix (over 65 % of the total weight), i.e. quartz sand grains of 0.02-3.0 mm in diameter, and a natural binding agent consisting of a fraction of grain size less than 0.02 mm in diameter. Two types of sands were distinguished as foundry sands: pure quartz sands containing maximum 2.0 % of the binder and natural sands containing from 2.0 % to 35 % of the binder. Now, seven types of foundry sands are distinguished depending on the content and mineral composition of the binding agent. An important feature of the raw material is also its sintering point. For casting steel a sintering point of 1,400^{0}C is required, for casting iron 1,350^{0}C, and for casts from non-ferrous metals 1,200^{0}C.

Deposits of foundry sands occur mainly in the central and southern parts of Poland (Plate 7). These deposits form usually beds, only in the Częstochowa region they occur in karst fillings in the Jurassic limestones. This raw material occurs in the measures of various periods: Jurassic, Cretaceous, Tertiary and Quaternary.

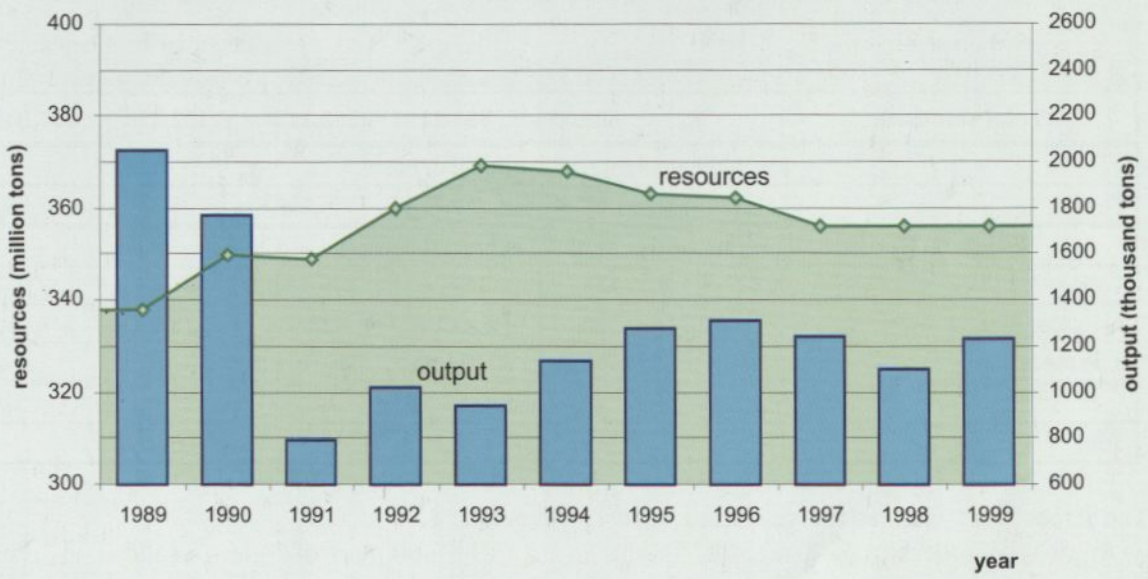
Jurassic foundry sands occur in the western part of the Cracow-Częstochowa Upland (the area between Gorzów Śląski and Żarki - sands and slightly compact sandstones belonging to the Lower and Middle Jurassic rocks) and in the north-west and the north-east of the surrounding of the Holy Cross Mountains (sands and slightly compact sandstones belonging to Liassic rocks near Szydłowiec, Wąchock, Skarżysko-Kamienna and Jagodno and also sands and sand sediments belonging to the Middle Jurassic rocks near Opoczno and Iłża).

Cretaceous sands occur mainly in the Tomaszów Basin where they accompany glass-making sands and in the Lower Silesia (in the middle-Sudetic synclinorium near Bolesławiec (slightly compact Coniacian sands).

Table 20.1 Foundry sands (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**78**	**355.75**	**204.97**	**150.78**	**6.01**	**72.36**
including reserves of exploited deposits						
Total	12	121.86	121.71	0.15	3.31	69.79
including resources of not exploited deposits						
Total	39	211.88	65.03	146.85	2.24	2.58
1. Exploration	18	68.98	65.03	3.95	2.10	2.58
2. Prospecting	21	142.90	-	142.90	0.13	-
including abandoned deposits						
Total	27	22.00	18.23	3.77	0.46	-

Fig. 20. 1 Foundry sands resources and output in Poland in 1989-99



Tertiary sands are Miocene and Oligocene land sediments (Lower Silesia, region of Konin-Koło-Turek, surroundings of the Holy Cross Mountains and in northern Poland, in Pomerania). Sea sediments, i.e. sands of sea origin occur near Świniary and Tarnobrzeg and also in the Lublin Upland.

Karst origin sands occur between Częstochowa and Zawiercie in karst hollows in the Jurassic rocks. The structure of the deposits is often complex and they are filled with natural sands with a high sintering point.

Quaternary sands (Pleistocene and Holocene ones) occur in almost every part of the country, but they are usually of low-quality and show a low sintering point.

The resources of foundry sand and state of their identification and management are presented in Table 20.1. The resources of foundry sands in all deposits amount to 355.75 million tons. Resources of the exploited deposits amount to 34.2 % of the total resources.

The exploitation of foundry sands in 1999 amounted to 1,230 thousand tons. The changes of foundry sand reserves and their output in the last decade (1989-1999) are shown in Fig 20.1.

In the course of draining the mines, 1,203 thousands m^3 of drinking and industrial waters were pumped off and 30 % of this quantity was utilized.

In view of the unfavourable location of foundry sand deposits, (mainly in the south of Poland) while foundries are distributed on the whole territory of the country it is necessary to conduct research-proving work in the northern part of Poland.

21. GLASS SANDS

Glass sands are the main raw material for the glass industry and their quality determines the quality of glass. Quartz flours of the same granulation as sands are used sometimes for optical glass products and for the best quality lead glass but this is usually due to the deficit of glass sands of the highest purity.

Glass sands occur in Poland (Plate 8) in thirty deposits five of which are in exploitation and in four of them the exploitation has been abandoned. The glass sand resources, the states of their identification and geological management are summarized in Table 21.1.

Table 21.1 Glass sands (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**30**	**607.33**	**355.11**	**252.22**	**122.22**	**207.04**
including reserves of exploited deposits						
Total	5	66.41	59.72	6.69	6.35	58.08
including resources of not exploited deposits						
Total	21	538.78	293.24	245.54	115.85	148.96
1. Exploration	13	342.07	293.24	48.83	78.19	148.96
2. Prospecting	8	196.70	-	196.70	37.67	-
including abandoned deposits						
Total	4	2.15	2.15	-	0.02	-

The deposits as well as the resources occur mainly in two voivodeships and regions: in the Tomaszów region near Piotrków Trybunalski, in the central Poland and in the Bolesławiec region near Jelenia Góra, in south-western Poland. The total country's resources of glass sands amount to 607 million tons of which 80.6 % are in the first region and 13.1 % in the Bolesławiec one. The remaining 6.3 % of domestic resources occur in several smaller deposits lying in different regions: Piła (1.3 % of the total resources), Tarnobrzeg (1.1 %) and Wyszków (1.6 %).

In the Bolesławiec region (northern part of the north-Sudetic basin) glass sands occur in the Cretaceous formations. The deposits of the Białogóra series near Tomaszów are also Cretaceous ones. The quartz sands occurring in the Tarnobrzeg region accompany the Miocene sulfur deposits.

The output of glass sands in Poland concentrates, like the deposits in the above-mentioned regions, i.e.: Bolesławiec and Tomaszów from where over 93 % of the total output is obtained.

The output in the Bolesławiec region is so big because of the high quality of the raw material in this region. The best glass sand classes occur in this region (from first to fourth) but most of the resources are classified as 1st to 2nd class. Sands of 1st to 2nd class do not occur in the remaining exploited deposits, while sand of 3rd class occurs in the Tomaszów region.

The annual output amounting to about 1.5 million tons is the measure of the country's consumption which indicates the minimum levels of imports and exports.

22. GOLD

Gold occurs in Zechstein copper ores in the pre-Sudetic Monocline (Plate 3). It is extracted during the processing of the ores. Gold resources have not been explored yet. Preliminary prospecting indicates that the resources which occur here amount to several dozen tons.

The company KGHM Polska Miedź S.A. extracted 490 kg of gold from the Lubin-Małomice, Polkowice, Rudna and Sieroszowice copper deposits in 1999.

Gold also occurs in the Sudetes in the deposit of gold and arsenic ores in Złoty Stok (Plate 3). The arsenic ores were explored in 1954-1960 and amounted to 714.4 thousand tons of intrinsically economic ores containing 25.5 % thousand tons of As. The resources remaining in the deposit amount to 536.5 thousand tons of ore, containing 19.6 thousand tons of As.

The resources of gold have been estimated at 2000 kg in the intrinsically economic ore and 490 kg in the potentially economic ore. The average gold content amounts to 2.8 gram per 1 ton of ore. So far, 25 % of the total resource have been exploited, so about 1,500 kg of gold remains. At present, no exploitation is conducted because there is no demand for arsenic and it has toxic properties.

The prospected resources of clastic gold in the Sudetes are estimated at about 2,300 kg (A. Wojciechowski 1993).

Exports of gold amounted to 516 kg in 1999, mainly in the form of crude gold of the value of PLN 8.1 thousand.

23. GYPSUM AND ANHYDRITES

The Miocene gypsum deposits occurring mainly in the Nida valley and the Zechstein gypsum and anhydrite deposits accompanying copper deposits in Lower Silesia of great importance in the Polish economy are (Plate 6).

The Nida valley is one of the richest gypsum-bearing regions in Poland. Gypsum occurs here in large area just under the ground surface or under a thin overburden (of 1.5-15 m). The gypsum bed thickness ranges from a minimum of 10 m to a maximum of 46 m. The content of $CaSO_4.2H_2O$ amounts to 85-95 %.

The Zechstein gypsum and anhydrite deposits contain varying quantities of the raw material and occur in complex geological conditions.

Apart from the resources in the explored deposits, considerable prospective resources (over 56 billion tons) have been explored in the overburden of the copper ore deposits in the Legnica-Głogów copper region.

The state of gypsum and anhydrite reserves and resources and the state of their management are presented in Table 23.1. The gypsum and anhydrite output amounted to 1,239 thousand tons in 1999. In 1994, production of synthetic gypsum, as by-product of desulfurisation of exhaust gases, began in coal-fired power plants. In 1999, the total capacity of this installations amounted to 800 thousand tons.

Table 23.1 Gypsum and anhydrites (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**15**	**269.76**	**193.52**	**76.24**	**25.96**	**112.71**
including reserves of exploited deposits						
Total	4	124.01	98.54	25.47	6.78	112.71
including resources of not exploited deposits						
Total	8	142.18	91.50	50.68	19.13	-
1. Exploration	6	108.92	91.50	17.42	17.90	-
2. Prospecting	2	33.26	-	33.26	1.23	-
including abandoned deposits						
Total	3	3.58	3.48	0.10	0.05	-

Fig 23.1 presents the resources and output of gypsum and anhydrite in Poland in the period 1989-1999. The domestic resources of gypsum and anhydrite allow to meet the whole demand of the Polish economy. Imports mainly of: gypsum plaster, gypsum building products amounted to about 450 thousand tons, and exports of those materials amounted to 353 thousand tons in 1999.

The quantity, value and main directions of gypsum imports and exports are presented in Table 23.2.

Fig. 23. 1 Gypsum and anhydrites resources and output in Poland in 1989-99

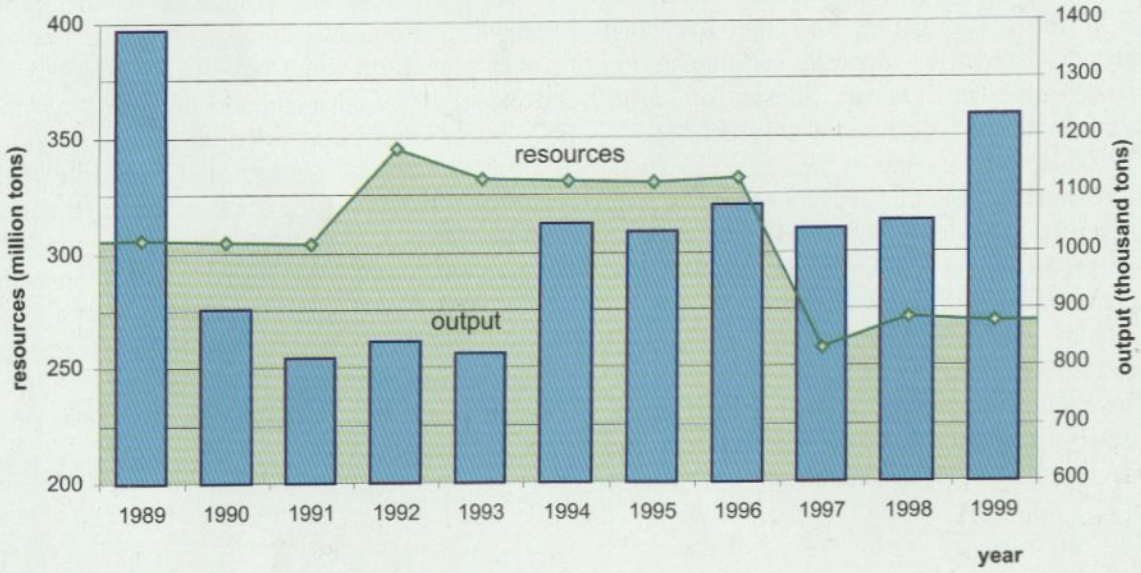


Table 23.2 Directions of Polish imports and exports of gypsum, gypsum plasters and gypsum building materials

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**449.39**	**172,576**		**Total**	**353.63**	**154,269**
1	Germany	421.93	146,298	1	USA, the	96.84	56,068
2	France	5.83	9,794	2	Germany	87.13	40,153
3	Czech Rep.	8.18	3,167	3	Ukraine	18.44	12,320
4	Austria	3.61	2,294	4	France	26.16	10,117
5	Belgium	1.90	2,255	5	Latvia	14.46	6,236
6	Switzerland	0.99	1,740	6	Canada	9.58	5,368
7	Norway	1.71	1,293	7	Russia	8.29	5,140
8	Denmark	0.48	1,161	8	Lithuania	9.45	4,440
9	United Kingdom,the	0.71	1,047	9	Czech Rep.	21.30	2,680
10	Sweden	0.16	955	10	Slovakia	49.01	2,365
11	Italy	0.36	703	11	Belarus	2.84	1,830
12	Moldova	2.38	676	12	Netherlands, the	0.45	1,405
13	USA, the	0.08	278	13	Estonia	3.35	1,370
14	Spain	0.22	276	14	Norway	1.90	983
15	Netherlands, the	0.12	228	15	Moldova	0.56	838
16	Portugal	0.12	98	16	Hungary	1.46	774
17	Latvia	0.22	86	17	Belgium	0.35	657

24. HARD COAL

Coal deposits occur in three basins in Poland, the most important being the Upper Silesian Coal Basin (Górnośląskie Zagłębie Węglowe - GZW. The others are: the Lower Silesian Hard Coal Basin (DZW) and the Lublin one (LZW) (Plate 2).

The area of the part of the (Górnośląskie Zagłębie Węglowe (GZW)) (Plate 2) located within Polish borders amounts to about 5,800 km^2 (Fig. 24.1). The exploited deposits cover 30 % of the area, the reserve deposits (identified but not exploited) with reserves identified with general and detailed exploration cover 23 %, and the perspective areas cover about 27 % of the whole area. Resources were estimated for to the depth 0 - 1000 m. The remaining area of the basin is mainly a region with prognostic resources and overburden exceeding 1,000 m and marginal parts of the basin with no expected economic resources of coal. Actually, over 80 % of coal deposits in Poland occur in this area.

The Lower Silesian Coal Basin (Dolnośląskie Zagłębie Węglowe (DZW)) is characterised by a considerable thickness variability as well as small horizontal and vertical extent of the coal-bearing formations. About 30 coal beds with thickness exceeding 1 m occur here. The identified and exploited deposits are in a zone of outcrops across an area of about 350 km^2. The difficult geological mining conditions and unprofitable exploitation result in mines being closed in this area. The identified resources are small in the Basin and amount to about 150 million tons, constituting only 0.25 % of the whole identified resources in Poland.

The Lublin Coal Basin (Lubelskie Zagłębie Węglowe (LZW)) (Plate 2) is in the early stage of management. The exploration of its borders is relatively poor. The area of 9,100 km^2 is assumed to be a perspective area for coal deposits and with thickness of the overburden ranging from 360 m to over 1,000 m. The one deposit being exploited occupies an area of 50 km^2 (0.5 %) and the deposits identified with general and detailed

exploration to a depth of 1,000 m cover about 67 % of the area. In the remaining area, the overburden exceeds 1,000 m and prospected potential resources have been estimated. The intrinsically economic reserves constitute a little more than 14 % of total Polish coal resources.

The adaptation of the coal mining industry to market economy has produced changes of the resources and output. In the recent years, a significant decrease of the resources has taken place. This is mainly due to the increased requirements of the balance criteria primarily as regards the minimal thickness of the coal bed established at 1.2 m of depth of the coal deposit at 1,000 m. Another reason of the reduction of the intrinsically economic reserves is the classification of the reserves in some unprofitable coal mines as potentially economic resources.

The identified intrinsically economic resources of coal deposits as at 31st December 1999 amounted to 46,846 million tons. The exploited resources of the deposit constitute actually about 38.8% of the intrinsically economic reserves and amount to 24,092 million tons.

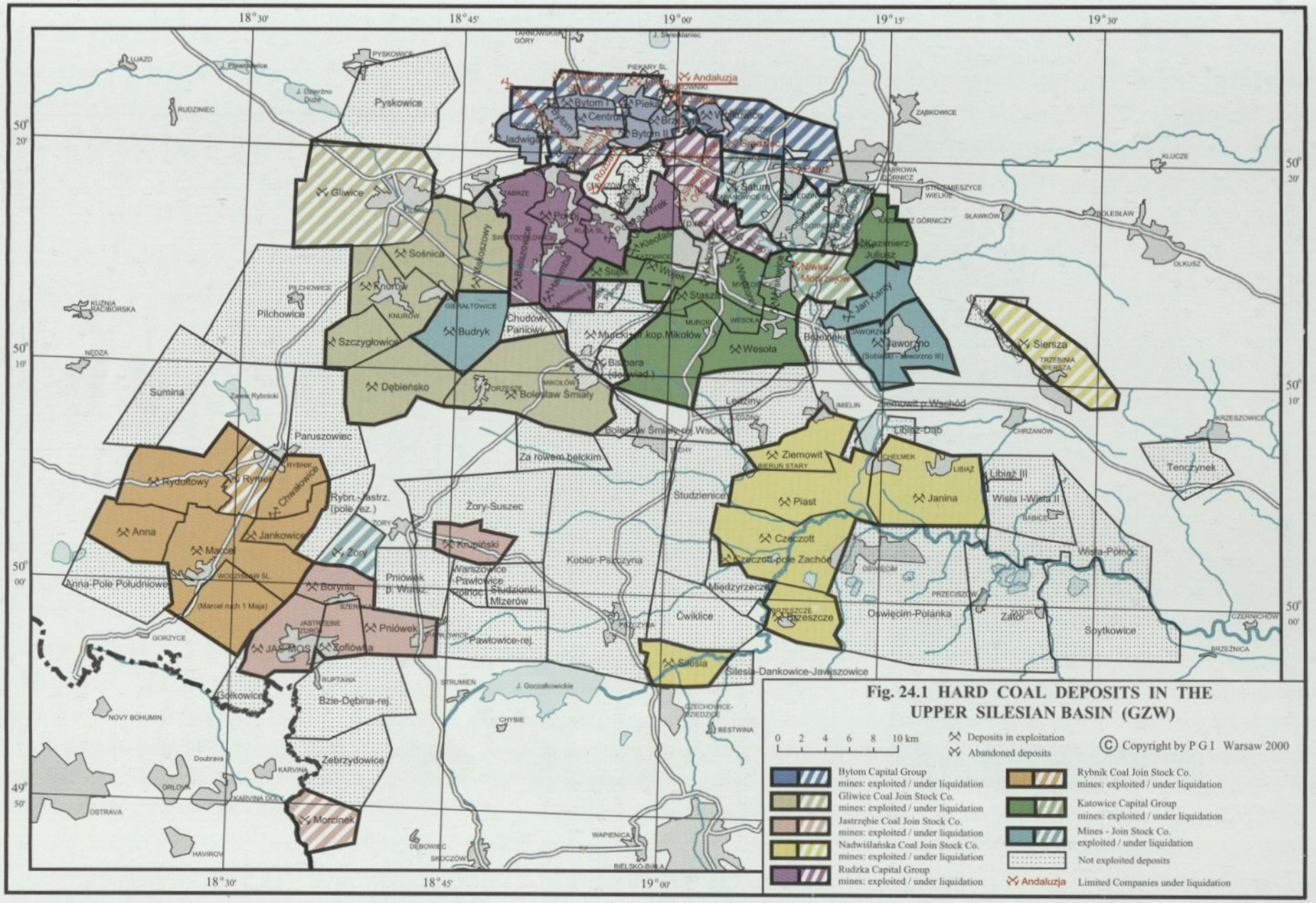
Identified coal resources, economic resources, as well as their identification, qualitative characteristic of the coal deposits and state of their management for the whole country are shown in Table 24.1.

The economic reserves of coal mines amount to 8,354 million tons in 1999.

Table 24.1 Hard coal (million tons)

Specification	Number of deposits	Reserves/resources					
		I E R				Potentially economic: marginal / submarginal	Economic reserves
		Total	Exploration A+B	Exploration C1	Prospecting C2		
Total resources	**128**	**46,845**	**4,809**	**12,908**	**29,128**	**16,926 / 12,843**	**8,354**
including reserves of exploited deposits							
Total	51	18,152	4,519	7,703	5,930	7,341 / 9,325	8,354
including resources of not exploited deposits							
Total	47	28,523	288	5,131	23,104	9,303 / 1,276	-
1. Exploration	29	15,230	288	4,892	10,050	3,973 / 1,169	-
2. Prospecting	18	13,293	-	239	13,054	5,330 / 107	-
including abandoned deposits							
Total	30	170	2	74	94	282 / 2,242	-

The net output of coal amounted to 109,986 thousand tons in 1999. After dramatic decrease in the previous years (Fig. 24.2) it reached the level of 100-110 million tons, forecasted for the nearest future.


18°30'
18°45'
19°00'
19°15'
19°30'
50°20'
50°10'
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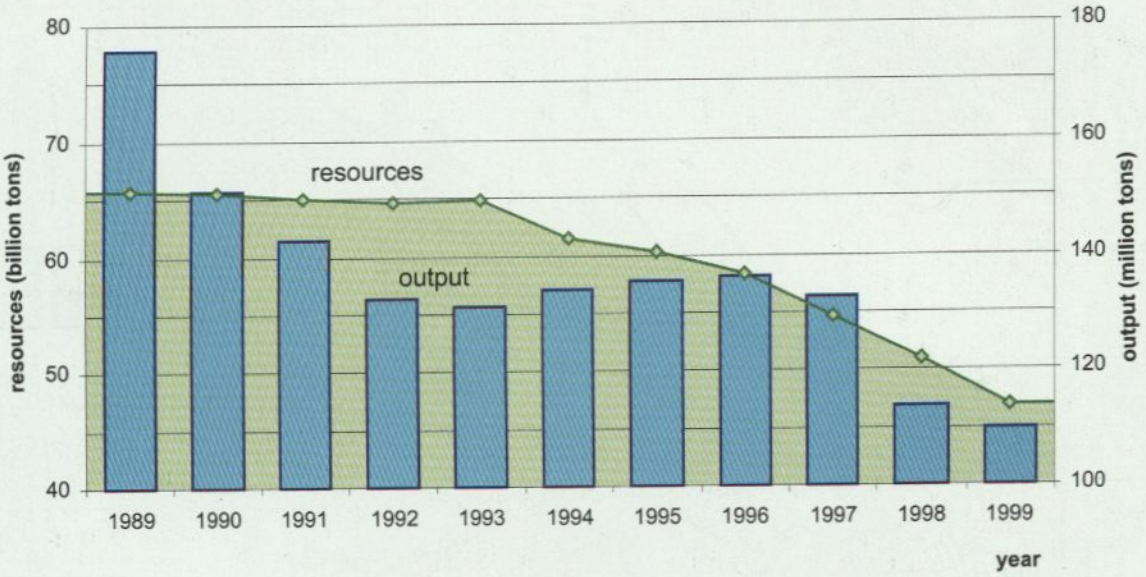
49°50'
Pyskowice
Gliwice
Sośnica
Knurów
Pilchowice
Szczygłowice
Budryk
Chudów
Paniowy
Dębieńsko
Bolesław Śmiały
Sumina
Paruszowiec
Rydułtowy
Rymer
Chwałowice
Rybn.-Jastrz. (pole rez.)
Anna
Marcel
Jankowice
Anna-Pole Południowe
Żory
Borynia
Pniówek
Jas-Mos
Zofiówka
Pniówek p. Warsz.
Krupiński
Żory-Suszec
Warszowice
Pawłowice Północ
Skidziorki-Mizerów
Pawłowice-rej.
Bzie-Dębina-rej.
Zebrzydowice
Morcinek
Kobiór-Pszczyna
Ćwiklice
Andaluzja
Bytom I
Centrum
Bytom II
Piekary
Brzezinka
Wirek
Saturn
Ruda
Kleofas
Ślask
Staszic
Wesoła
Mysłowice
Murcki-kr.kop.Mikołów
Barbara (rez.wiad.)
Boleslaw Śmiały-ow.Wschód
Za rowem Bełckim
Studzienice
Międzyrzecze
Przeszczce
Silesia
Silesia-Dankowice-Jaworzno
Jan Kanty
Jaworzno
Jaworzno III
Brzezinka
Siersza
Trzebinia Siersza
Ziemowit
Piast
Janina
Czeczott
Czeczott-pole Zachód
Libiąż
Libiąż III
Wisła I-Wisła II
Wisła-Północ
Oświęcim-Polanka
Zator
Sołtkowice
Tenczynek
Ziemowit p.Wschód
Libiąż-Dąb
Łężiny
Kazimierz Juliusz
Sierszka
Fig. 24.1 HARD COAL DEPOSITS IN THE UPPER SILESIAN BASIN (GZW)
0 2 4 6 8 10 km
Deposits in exploitation
Abandoned deposits
© Copyright by P G I Warsaw 2000
Bytom Capital Group mines: exploited / under liquidation
Gliwice Coal Join Stock Co. mines: exploited / under liquidation
Jastrzębie Coal Join Stock Co. mines: exploited / under liquidation
Nadwiślańska Coal Join Stock Co. mines: exploited / under liquidation
Rudzka Capital Group mines: exploited / under liquidation
Rybnik Coal Join Stock Co. mines: exploited / under liquidation
Katowice Capital Group mines: exploited / under liquidation
Mines - Join Stock Co. exploited / under liquidation
Not exploited deposits
Andaluzja Limited Companies under liquidation

Fig. 24. 2 Hard coal resources and output in Poland in 1989-99



The exploitation of coal was accompanied by the production of 27,436 thousand tons of mining wastes, 25,651 thousand tons of which were used for various purposes (e.g. ground levelling, engineering work, etc.) while 1,785 thousand tons were dumped on coal mine dumps or so called central dumps.

Mine drainage reached 225 million m^3 of water in 1999 and 75 million m^3 (33.1 %) of the water was utilized, while 151 million m^3 was drained to the rivers and streams of the Vistula and Odra drainage abysal.

More than 24.1 % of excavated coal is designed for exports. The directions of Polish exports of coal, coke, semi-coke and coke chemical products are shown in Table 24.2 and imports of coal and chemical coke products - in Table 24.3

Table 24.2 Directions of Polish export of hard coal (including anthracite), coke, semi-coke and chemical-coke products

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Hard coal							
	Total	**24,104**	**3,034,929**				
1	Germany	6,440	669,321	16	Spain	610	68,950
2	Denmark	2,436	246,667	17	Mauritania	623	62,535
3	Finland	1,674	239,418	18	Ukraine	614	62,003
4	Austria	1,521	222,833	19	Italy	501	57,391
5	Slovakia	1,247	222,317	20	Bulgaria	230	33,204
6	United Kingdom, the	1,172	171,956	21	Belgium	324	32,327
7	Czech Rep.	1,015	123,586	22	Turkey	217	31,060
8	Netherlands, the	852	116,654	23	Norway	137	27,256
9	France	840	104,981	24	Israel	175	19,773
10	Sweden	769	104,870	25	Trinidad and Tobago	122	12,186
11	Brazil	586	83,039	26	Russia	54	5,242
12	Egypt	553	82,161	27	Slovenia	11	2,111
13	Ireland	280	80,341	28	Jugoslavia	13	1,720

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
14	Hungary	541	77,597	29	Lithuania	8	1,370
15	Romania	511	69,245	30	Croatia	10	1,166
	Coke and semi-coke						
	Total	**2,875**	**844,570**				
1	Germany	1,894	554,808	13	United Kingdom, the	24	6,393
2	Czech Rep.	271	68,006	14	Romania	20	5,538
3	Brazil	188	50,710	15	Sweden	19	5,401
4	Norway	85	40,597	16	Iceland	6	4,195
5	Austria	108	30,078	17	Belarus	5	2,605
6	Slovakia	57	16,447	18	France	7	2,117
7	Macedonia	38	11,903	19	Greece	7	1,797
8	Netherlands, the	24	8,547	20	Hungary	5	1,518
9	Finland	22	7,780	21	Spain	4	1,078
10	Belgium	32	7,593	22	Jugoslavia	2	988
11	Turkey	33	6,818	23	Lithuania	2	913
12	Egypt	16	6,732	24	Ireland	2	800
	Chemical-coke products						
	Świat (ogółem)	**355**	**108 451**				
1	Czech Rep.	114	35,584	6	Ukraine	5	2,762
2	Germany	99	27,076	7	Italy	4	1,859
3	Denmark	66	21,050	8	Austria	3	1,275
4	Spain	55	13,950	9	Netherlands, the	2	827
5	Norway	5	2,826	10	Russia	1	689

Table 24.3 Directions of Polish import of hard coal (including anthracite), coke, semi-coke and chemical-coke products

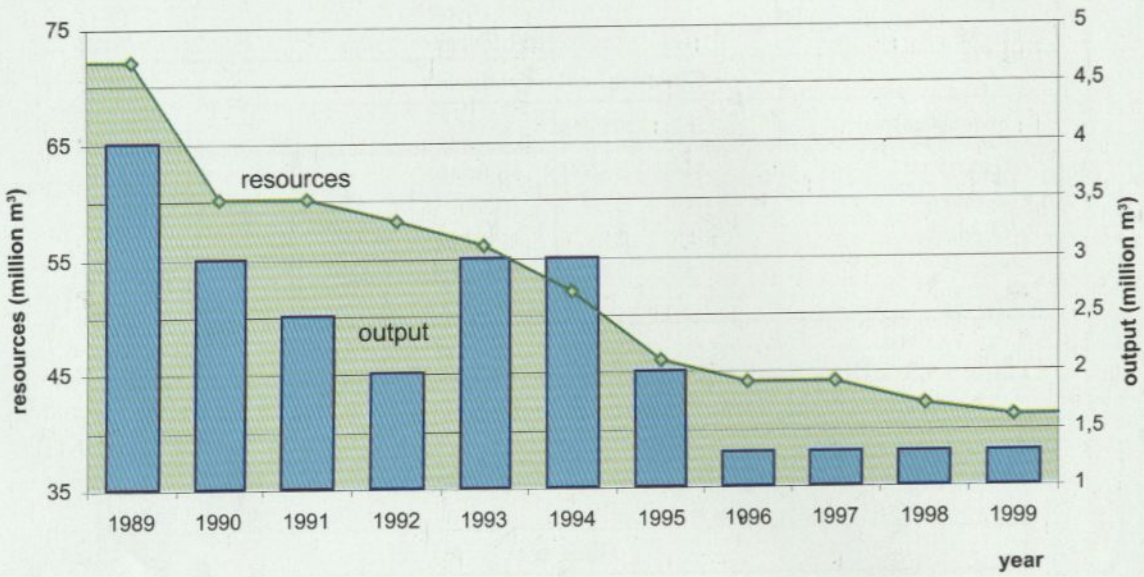
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Hard coal						
	Total	**2,374**	**329,309**				
1	Russia	1,102	143,261	6	Norway	2	3,305
2	Czech Rep.	952	132,182	7	Cyprus	12	1,752
3	South Africa	247	34,534	8	Australasia	9	1,258
5	Colombia	25	4,104	10	Germany	1	284
	Coke and semi-coke						
	Total	**18**	**8 595**				
1	Czech Rep.	10	2,717	3	Japan	1	2 044
2	China	5	2,631	4	France	1	1 100
	Chemical-coke products						
	Total	**47**	**30,347**				
1	Germany	8	8,695	4	Slovakia	14	4,302
2	Japan	4	6,644	5	Ukraine	8	2,261
3	Czech Rep.	10	5,844	6	France	1	1,101

25. HELIUM

Helium, an element belonging to the group of noble gases, is chemically neutral. Due to its cryogenic properties, helium is used in low temperature technologies and in superconductors. The main source of helium are fields of natural gas with a high nitrogen content. In the USA, gas fields containing a minimum of 0.3 % of helium are considered as helium-bearing sources.

Helim occurs in almost every gas field in the Polish Lowland (Niż Polski), however, is has been proved only at 14 sites.The contents of helium in natural gas ranges form 0.08 to 0.45 %. It is extracted from the natural gas with a helium content excceding 0.27 % in the Nitorgen-Separation Plant in Odolanów.

Fig. 25. 1 Helium resources and output in Poland in 1989-99



26. IRON

Practically, iron ore deposits are scarce in Poland. The sedimentary iron ore which was exploited in 20 thc. dees not meet the present requirewenls for iron ore while the titanium-magnetite deposits in the Suwałki massif in north-eastern Poland (at Krzemianka and Udryń) - classified as potentially economic. Actually, these deposits are not exploited and due to the big depth of the occurrence their exploitation does not seem to be economically justified.

The total domestic demand for iron ores is metby imports. The imports amounted to 7,641 thousand tons in 1999, mainly in the form of concentrates or ores and pig iron. The total imports and exports of iron ores, concentrates and iron products, i.e. ferroalloys, alloy pig iron and non-alloy pig iron, Fe compounds, wastes and scrap, granules and powders are presented in Table 26.1.

Table 26.1 Directions of Polish imports and exports of iron

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**7,641**	**1,109,734**		**Total**	**899**	**423,217**
1	Ukraine	4,301	404,150	1	Germany	553	283,706
2	Russia	1,967	238,524	2	USA, the	51	25,711
3	Germany	14	93,022	3	Czech Rep.	51	18,370
4	Slovakia	34	62,530	4	Spain	65	16,996
5	South Africa	617	59,704	5	Malaysia	49	14,590
6	Brazil	417	48,154	6	Netherlands, the	15	10,595
7	Sweden	173	33,552	7	Belgium	13	9,927
8	France	13	32,750	8	Taiwan	33	9,348
9	Czech Rep.	15	24,945	9	United Kingdom, the	13	6,697
10	Norway	19	18,789	10	Sweden	9	5,356
11	Belgium	33	18,298	11	Austria	3	3,496
12	Spain	13	18,171	12	Denmark	17	3,489
13	China	2	15,619	13	France	7	2,807
14	United Kingdom, the	2	9,221	14	Luxembourg	1	2,371
15	Netherlands, the	1	6,072	15	Italy	2	2,362
16	Hungary	0.1	4,125	16	Portugal	9	2,050
17	Italy	0.6	4,092	17	Slovakia	4	1,736
18	Austria	0.1	3,528	18	Unidentified country	4	1,216
19	Slovenia	0.9	3,454	19	Ukraine	0.1	735
20	USA, the	12	2,684	20	Hungary	0.3	337
21	Kazakhstan	0.8	2,072	21	Russia	0.1	278
22	Libya	3	1,383	22	Lithuania	0.1	234
23	Finlandia	0.0	820	23	Moldova	0.1	170
24	Denmark	0.1	694	24	Norway	0.1	167
25	Macedonia	0.3	542	25	Estonia	0.1	152
26	Iran	0.3	525	26	Jugoslavia	0.0	77

27. KAOLIN

The Polish term "kaolin" relates to a rock with a high contents of the kaolinite mineral which is characterized by enabling the kaolin raw material to be extracted from it (e.g. by mechanical processing). The Polish term in British terminology corresponds to "China clay" or "ball clay" approximately.

Residual and sedimentary kaolin deposits can be utilized in their natural form in the refractory material industry for chamotte products. Other uses in the ceramic, paper, rubber, chemical and food industries require an enriched material obtained by flushing, flotation, acid breatment, electrophoresis, etc.

In Poland, kaolin deposits occur in Lower Silesia (Plate 7). They are related with the massifs of granites and acid metamorphic rocks in the Sudetes and pre-Sudetic block.

The deposits of kaolin are of residual or redeposited types and occur where the mother rocks appear. Sandstones with kaolinite binder occur in the north-Sudetic depression. All the deposits are Tertiary.

The resources of kaolin raw materials amount to 208.6 million tons. The state of resources of the raw materials and the state of their management are presented in Table 27.1.

Table 27.1 Kaolin raw materials (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**13**	**208.63**	**135.08**	**73.55**	**53.49**	**67.80**
including reserves of exploited deposits						
Total	1	75.96	75.96	-	7.44	67.80
including resources of not exploited deposits						
Total	10	123.46	49.91	73.55	41.67	-
1. Exploration	5	52.22	49.91	2.31	29.67	-
2. Prospecting	5	71.24	-	71.24	12.00	-
including abandoned deposits						
Total	2	9.20	9.20	-	4.38	-

The exploitation of kaolin raw materials was conducted in the Maria III deposit near Bolesławiec and amounted to 208.6 thousand tons in 1999. The demand of Polish industry is balanced by imports. Imports of kaolins amounted to 547 thousand tons in 1999, including 47.2 thousand tons of crude kaolin and 7.5 thousand tons of burned kaolin. Only 3.3 thousand tons of kaolin were exported in the same period of time (Table 27.2).

Table 27.2 Directions of Polish imports and exports of kaolin and kaolin clay

Import				Eksport			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**54.66**	**37,283**		**Total**	**3.34**	**307**
1	Germany	18.55	12,826	1	Slovakia	3.10	165
2	United Kingdom, the	9.13	8,177	2	Norway	0.05	42
3	Czech Rep.	16.11	7,698	3	Lithuania	0.09	29
4	Spain	5.09	4,614	4	Belgium	0.03	29
5	USA, the	1.91	2,751	5	Czech Rep.	0.02	17

28. LIGNITE

In Poland lignite occurs in Tertiary sediments, which stretch mainly in the Polish Lowland (Niż Polski) and in small areas in the Carpathians (Karpaty) and the Carpathian Foredeep (Zapadlisko Przedkarpackie), as well as in measures of the Upper Cretaceous or Lower Jurassic (Plate 2).

In the Tertiary measures, lignite forms single beds, lentils or complexes of beds in sediments belonging to the periods from Paleocene to Upper Miocene. The most important from the eco-nomic aspect are, however, the Middle Miocene sediments. The surface of the Tertiary lignite-bearing area in the Polish Lowland amounts to almost 100.000 km^2. The identified deposits with resources cover an area of about 930 km^2 and together with the estimated perspective deposits about 4,500 km^2.

The identified deposits occur mainly in the western, southern and central parts of the country. The identified resources of lignite amount to 14,051 million tons, including 3,013 million tons of briquette lignite, 1,875 million tons of lignite for low temperature carbonisation, and 0.8 million tons of bituminous lignite (Table 28.1).

Table 28.1 Lignite (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**78**	**14,050.71**	**4,521.25**	**9,529.46**	**4,847.36**	**1,877.76**
including reserves of exploited deposits						
Total	11	2,145.04	1,951.67	193.37	179.56	1,794.96
including resources of not exploited deposits						
Total	62	11,896.40	2,560.95	9,335.45	4,663.53	82.80
1. Exploration	31	2,833.51	2,517.20	316.31	705.52	82.80
2. Prospecting	31	9,062.89	43.75	9,019.14	3,958.01	-
including abandoned deposits						
Total	5	9.28	8.64	0.64	4.27	-

The resources of exploited deposits constitute 15.3 % of the identified resources and amount to 2,145 million tons. The deposits are exploited in five open pit mines: Adamów, Bełchatów, Konin, Sieniawa and Turów; a newly open pit mine Szczerców being now under construction.

The prognosis of lignite output should not include the area of Poznań graben, i.e. the deposits of Czempin, Krzywin and Gostynin. These deposits may not be exploited in the foreseeable future due to the land surface and arable land protection. Their resources amount to 3,690 million tons.

The lignite economic reserves of the exploited deposits amount to 1,795 million tons and constitute 84 % of their identified resources.

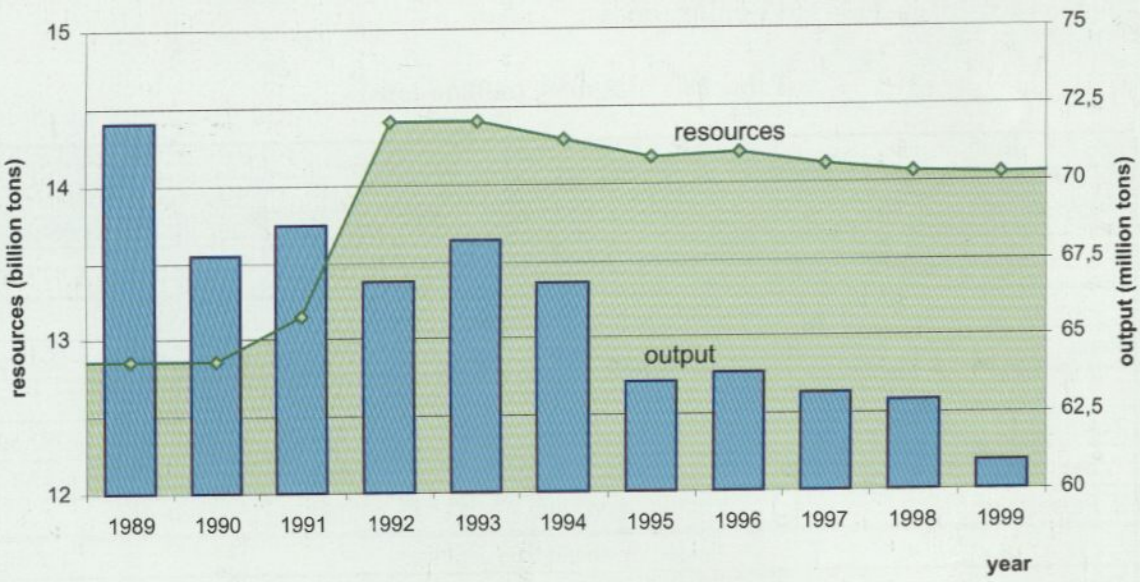
The lignite output in the period 1989 to 1999 is shown in Fig. 28.1. In 1999, the output amounted to 60,860 thousand tons, the Bełchatów deposit accounting for 58.3 % and the Turów deposit for 14.7 %.

Almost the whole lignite output was consumed by power stations, and only 33 thousand tons was exported to Germany and Slovakia for about PLN 5.3 million.

Lignite mining generates a large dump of overburden. In Poland, the biggest dump lies at the Bełchatów open pit. The overburden located on the outer dumps is not considered to be waste according to the NSA (Chief Administrational Court) verdict.

Mine waters, pumped during lignite exploitation, are drinking and industrial waters. Out of the total of 409 million m^3 of mine water, about 47.8 % comes from the Bełchatów open pit, while only 0.3 % of it is utilised.

Fig. 28. 1 Lignite resources and outputin Poland in 1989-99



29. LIMESTONES AND MARLS FOR CEMENT AND LIME INDUSTRIES

Limestones and marls are used in the production of cement and lime (building and industrial lime) and also in the metallurgy and food industries (sugar industry).

These raw materials occur in the following regions of Poland (Plate 6):

- Lower Silesia – Cambrian and Triassic formations,
- Silesian-Cracow area – Triassic, Jurassic and Cretaceous formations,
- Holy Cross Mountains – Devonian, Triassic, Jurassic, Cretaceous and Tertiary formations,
- Carpathians – Cretaceous formations,
- Lublin area – Cretaceous formations, and
- Kujawy-Pomeranian area – Jurassic formations.

The reserves and resources of limestones and marls for lime and cement industry and also the state of their management are presented in Table 29.1.

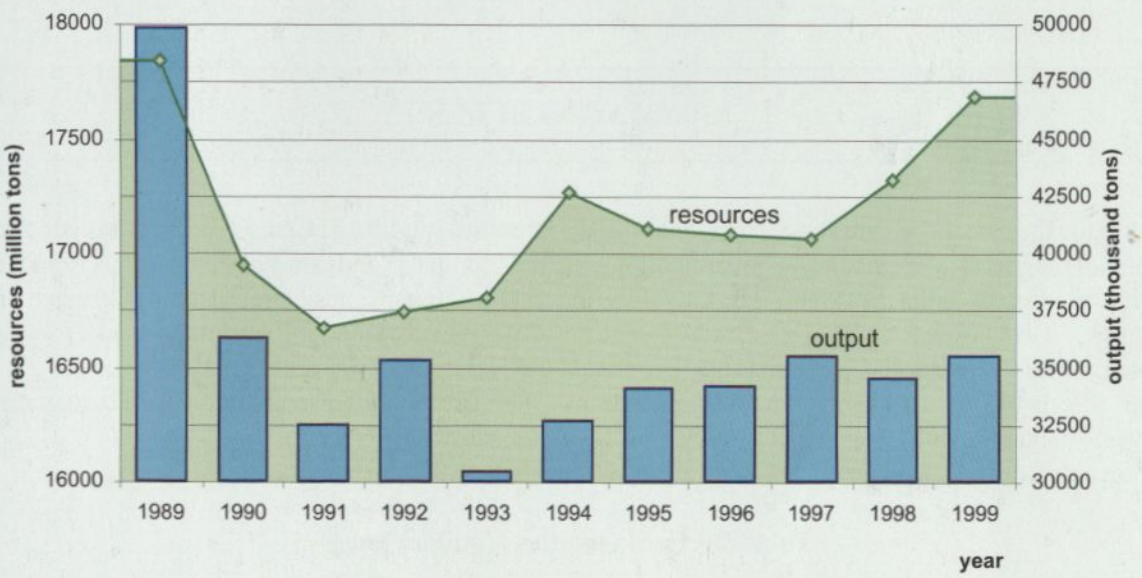
The output of calcareous raw materials amounted to 35.5 thousand tons in 1999, including 23.1 thousand tons for the cement industry, and 12.4 thousand tons for the lime industry. Fig 29.1 shows limestone and marl resources and their output in Poland in the period 1989-1999.

The resources of limestones and marls for cement and lime industries satisfy the total country's demand and make possible considerable exports of limestone processed products. Exports in 1999 amounted to 800 thousand tons of cement and lime.

Table 29.1 Limestones and marls for cement and lime industry (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**182**	**17,680**	**9,743**	**7,936**	**1,665**	**4,019**
including reserves of exploited deposits						
Total	36	5,770	4,758	1,011	174	3,905
including resources of not exploited deposits						
Total	99	11,083	4,303	6,780	1,451	39
1. Exploration	61	5,207	4,162	1,046	737	39
2. Prospecting	38	5,876	141	5,734	714	0
including abandoned deposits						
Total	47	827	682	145	40	75

Fig. 29. 1 Resources and output of limestones and marls for cement and lime industries in Poland in 1989-99



The quantity, value and main directions of imports and exports are shown in Table 29.2.

The existing base of the explored resources of the above-mentioned raw materials will balance the Polish industry demand for a long time yet. Actually, the perspective resources concentrate in the following regions: Holy Cross Mountain, Opole, Częstochowa and Lublin areas and totally amounted to over 90 billion tons.

Table 29.2 Directions of Polish imports and exports of cement, clinker and lime

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**834.1**	**101,483**		**Total**	**2,905.3**	**314,045**
1	Czech Rep.	425.8	35,526	1	Germany	2,670.3	273,157
2	Germany	108.3	18,497	2	Netherlands, the	149.5	26,511
3	Estonia	67.0	11,085	3	Czech Rep.	31.0	4,701
4	Slovakia	52.5	8,990	4	United Kingdom, the	23.6	2,700
5	Ukraine	119.8	8,651	5	Sweden	12.5	1,680
6	Denmark	13.0	6,062	6	Russia	1.2	903
7	France	2.5	3,393	7	Slovakia	8.7	801
8	Spain	0.6	1,951	8	Lithuania	1.3	781
9	Belarus	14.6	1,520	9	Ghana	2.2	711
10	Sweden	27.1	1,329	10	Denmark	2.2	483
11	Croatia	1.1	1,180	11	Ukraine	0.9	433
12	Canada	0.1	853	12	Moldova	0.1	211
13	Switzerland	0.3	718	13	Switzerland	0.4	150
14	Belgium	0.9	669	14	Belgium	0.1	142

30. MAGNESITES

Magnesites occur in ultrabasic rock massifs. In Poland, magnesite deposits occur in serpentinite massifs in Lower Silesia (Plate 7): Gogołów-Jordanów, Grochowa-Braszowice, Szklary and Sobótka. All the explored deposits are in the Lower Silesia (dolnośląskie) voivodeship. These are vein deposits with veins 3 m thick, of a complex geological structure and varying raw material quality. The magnesites in Polish deposits are compact and amorphous and as opposed to crystal magnesites, are used only in limited quantities as an additive to magnesites used in the refractory material production.

The resources and state of their management are shown in Table 30.1.

Table 30.1 Magnesites (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**6**	**11.84**	**2.63**	**9.21**	**4.56**	**5.51**
including reserves of exploited deposits						
Total	2	5.74	2.63	3.11	2.38	5.51
including resources of not exploited deposits						
Total	4	6.10	-	6.10	2.18	-

Table 30.2 Directions of Polish import of magnesite and magnesite products

	Country	thousand tons	thousand tons
	Total	**23.37**	**35,694**
1	Germany	1.45	7,333
2	United Kingdom, the	4.25	8,639
3	Brazil	5.61	6,459
4	Austria	1.06	4,397
5	China	2.93	2,620
6	Ireland	1.18	1,726
7	Israel	0.47	1,310
8	Slovakia	5.55	599
9	USA, the	0.11	579
10	France	0.04	473

Resource of magnesites amount to 11.8 million tons. Half of the explored magnesite resources occur in two deposits being exploited (Braszowice and Wiry).

The output of magnesite amounted to 54.8 thousand tons in 1999. This quantity did not meet the domestic demand, especially in view of the poor quality. Therefore, of imports of magnesite were significant and amounted to 23.37 million tons in 1999.

The magnesite raw materials are used in great quantities in the production of magnesium

The directions of Polish imports of magnesites and magnesite products are summarized in Table 30.2.

fertilizers for agriculture. Magnesite for the refractory material industry and for the metallurgy comes from imports.

31. METALS AND ELEMENTS COEXISTING IN ORES AND IN OTHER RAW MATERIALS

Metallic elements coexist mainly in ore deposits. Many of them, coexisting in zinc, lead and copper ore deposits, are extracted or can be extracted in the course of processing of the ore. Rare and dispersed elements have also been found in salts and brines. The resources of the elements are presented in Table 31.1.

The group of the raw materials in question ontains also such metals which do not occur in the deposits in Poland or are not reclaimed. The domestic demand for these metals (mainly aluminium, chromium, cobalt, magnesium, manganese, titanium and wolfram) is fully balanced by imports or possibly by utilization of non-mineral waste raw materials (Table 31.2).

Table 31.1 Comparison of resources of coexisting metal and elements occurring in ores and other raw materials (in thousand tons)

Elements	In copper ores	In zinc and lead ores	In other raw materials deposits	Total
Boron	-	-	6.00	6.00
Bromine	-	-	7.20	7.20
Br - J (brines)	-	-	321 million m^3	321 million m^3
Zirconium	-	-	2.00	2.00
Gallium	-	0.16	-	0.16
Germanium	-	0.07	-	0.07
Cadmium	-	66.45	-	66.45
Cobalt	151.00	-	-	151.00
Molybdenum	87.96	-	-	87.96
Rhenium	0.06	-	-	0.06
Thallium	-	11.89	-	11.89
Titanium (Ti)	-	-	12.00	12.00

Table 31.2 Directions of Polish imports and exports of aluminium, cobalt, chromium, magnesium, manganese, precious metals (and their compounds), platinum, wolfram and gold

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Aluminium							
	Total	**315.73**	**903 123**		**Total**	**99.89**	**309,501**
1	Russia	63.81	340,734	1	Germany	48.87	150,522
2	Germany	53.24	117,368	2	Austria	10.65	44,457
3	Slovakia	15.54	101,439	3	Czech Rep.	6.73	33,564
4	Iran	58.62	49,835	4	United Kingdom,the	5.39	21,521
5	Sweden	7.61	40,943	5	Hungary	3.07	13,980
6	Ukraine	9.90	29,052	6	Luxembourg	1.41	11,193
7	France	4.26	25,948	7	Italy	1.92	9,056
8	Brazil	5.14	25,347	8	Netherlands, the	5.52	6,347
9	United Arab Emirates,the	3.27	22,148	9	Japan	0.59	3,314
10	Irlandia	30.02	19,433	10	Belgium	3.32	2,620
11	Austria	2.64	19,065	11	Israel	0.34	1,890
12	Norway	2.938	18,601	12	Denmark	0.72	1,765
13	Hungary	16.71	13,909	13	Sweden	0.79	1,585
14	Luxembourg	1.50	12,359	14	Croatia	0.26	1,549
15	China	9.04	8,749	15	Norway	5.88	1,151
16	Lithuania	1.86	7,165	16	Slovakia	0.16	927
17	Moldova	2.09	6,563	17	Bulgaria	0.13	596
18	Czech Rep.	4.20	6,323	18	Slovenia	0.29	538
19	Argentina	0.93	5,464	19	Switzerland	0.08	350
20	Australia	9.91	5,119	20	Ukraine	0.05	348
21	Slovenia	1.01	3,835	21	Azerbaijan	0.07	312
22	Bahrain	0.60	3,516	22	Lithuania	1.26	284
23	USA, the	0.48	3,195	23	France	0.11	246
24	United Kingdom, the	0.49	3,174	24	Russia	0.51	240
25	Italy	0.51	2,453	25	Suazi (Ngwane)	0.05	226
26	Netherlands, the	0.22	1,818	26	Latvia	1.05	223
27	India	0.36	1,201	27	Morocco	0.06	171
28	Japan	0.13	1,170	28	Spain	0.07	109
29	Bosnia-Herzegovina	3.21	1,087	29	Iran	0.02	96
30	Kazakhstan	0.32	1,013	30	St Thomas Islands	0.02	96
31	Greece	3.92	995	31	Georgia	0.00	58
32	Unidentified country	0.39	964	32	Finland	0.07	43
33	Romania	0.15	666	33	Romania	0.30	42
34	Egypt	0.07	533	34	Greece	0.04	23
Cobalt							
	Total	**0.084**	**8,311**		**Total**	**0.029**	**961**
1	Finland	0.022	2,936	1	Netherlands, the	0.004	496
2	Russia	0.019	1,690	2	Germany	0.025	442
3	Belgium	0.010	1,586	3	Romania	0.000	23
4	Germany	0.007	1,009				

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Chromium						
	Total	**33.13**	**24,470**		**Total**	**6.97**	**28,465**
1	South Africa	10.16	5,702	1	Germany	3.86	11,411
2	Turkey	12.13	5,424	2	Italy	0.57	4,019
3	Kazakhstan	8.92	3,774	3	United Kingdom, the	0.48	3,371
4	Germany	0.23	3,290	4	USA	0.33	3,269
5	Netherlands, the	0.37	1,876	5	France	1.14	3,003
6	Pakistan	1.00	1,041	6	Spain	0.21	1,298
7	Hungary	0.03	742	7	Czech Rep.	0.05	405
8	USA, the	0.02	664	8	Lithuania	0.14	402
9	Belgium	0.04	586	9	Austria	0.04	296
	Magnesium						
	Total	**63.56**	**75,913**		**Total**	**2.27**	**1,679**
1	China	17.43	26,390	1	Belgium	0.63	336
2	Slovakia	17.68	13,157	2	Netherlands, the	0.13	270
3	Brazil	13.67	12,351	3	Czech Rep.	0.34	211
4	France	4.29	8,011	4	Spain	0.29	181
5	Germany	4.13	3,670	5	Finland	0.21	129
6	Israel	1.32	3,249	6	Germany	0.07	103
7	Netherlands, the	1.95	2,713	7	United Kingdom,the	0.16	97
8	Australia	1.52	2,338	8	Lithuania	0.09	96
9	Turkey	0.06	747	9	Italy	0.07	42
10	Austria	0.44	631	10	Slovakia	0.03	41
11	Canada	0.03	569	11	Sweden	0.07	41
12	Russia	0.10	559	12	Tunisia	0.04	35
	Manganese						
	Total	**14.98**	**29,896**		**Total**	**0.021**	**63**
1	Ireland	2.34	12,901	1	Germany	0.01	38
2	Belgium	1.52	5,040	2	Netherlands, the	0.01	18
3	Gabon	2.11	2,975	3	Italy	0.00	6
4	Greece	0.51	2,837	4	Czech Rep.	0.00	1
5	Ukraine	5.59	1,416				
6	China	0.36	1,310				
7	Mexico	0.51	786				
8	Bulgaria	1.34	540				
	Precious metals and their compounds (excludes gold and platinum) (tons)						
	Total	**183.92**	**43,703**		**Total**	**95.30**	**12,436**
1	United Kingdom, the	155.82	37,243	1	Germany	89.07	7,882
2	USA, the	16.40	3,744	2	United Kingdom, the	2.00	3,696
3	Netherlands, the	1.20	1,029	3	Italy	2.75	221
4	Germany	2.31	926	4	France	0.03	149

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Platinum (tons)						
	Total	**18.42**	**16,622**		**Total**	**2.34**	**14,945**
1	United Kingdom, the	0.18	8,599	1	United Kingdom,the	0.18	9,521
2	France	0.12	7,356	2	Germany	1.72	4,665
3	Italy	16.87	578	3	Lithuania	0.02	726
	Wolfram						
	Total	**0.23**	**7,988**		**Total**	**0.72**	**12,791**
1	Czech Rep.	0.16	6,902	1	Czech Rep.	0.21	8,990
2	Russia	0.03	556	2	USA, the	0.22	1,459
3	China	0.02	392	3	Germany	0.15	1,419
4	Germany	0.00	54	4	Austria	0.13	886

32. NATURAL AGGREGATES

The resource base of natural aggregates exceeds 14.5 billion tons in 3,915 deposits. The deposits are distributed throughout Poland in all voivodeships.

The identification and management structure of the resources are shown in Fig 32.1.

Fig. 32.1 The distribution of natural aggregate resources in Poland

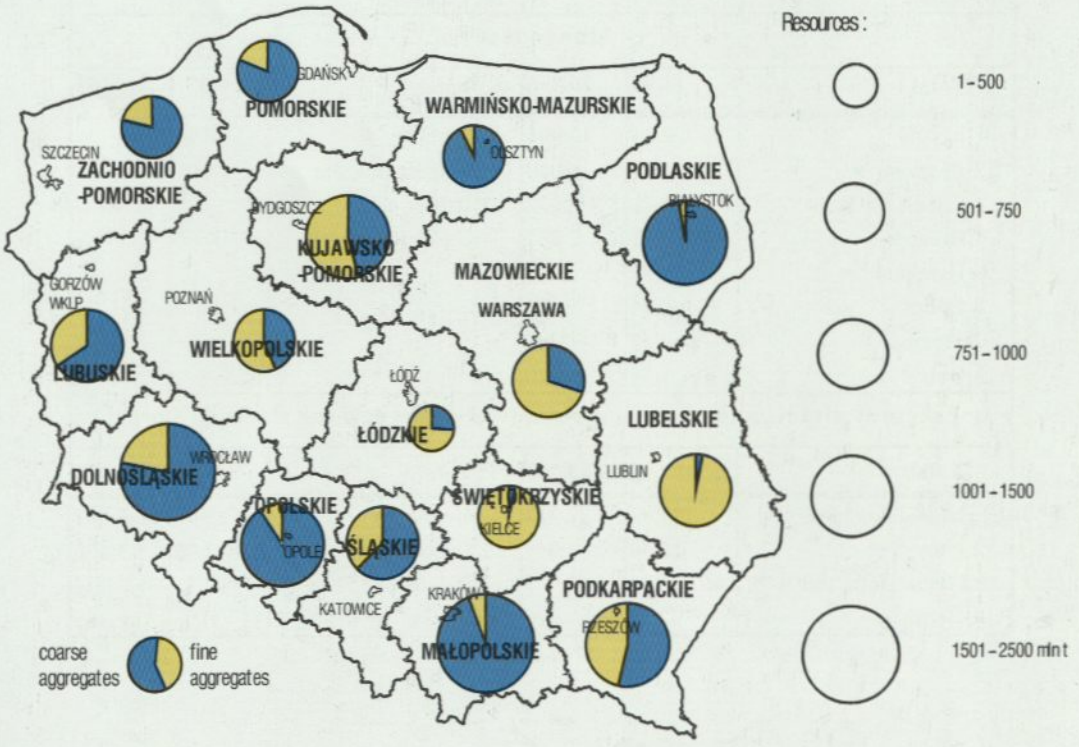


Plate 8 presents the localization of natural aggregates deposits with resources over 1 million tons in each. There are 1,100 such deposits. Their total resources constitute almost 96 % of the domestic resources. The plate does not present localization of small deposits of local importance only. Despite their large number (2,815), the total resources amount the to only 4 % of the domestic resources. Frequency of the occurring of various magnitude deposits of natural aggregates in Poland are shown in Fig. 32.2.

Unfortunately, the natural aggregate potential of the particular regions of Poland is diverse. The most valuable are coarse-grained aggregates (gravel and sand-gravel mix). Fine-grained aggregates include sands.

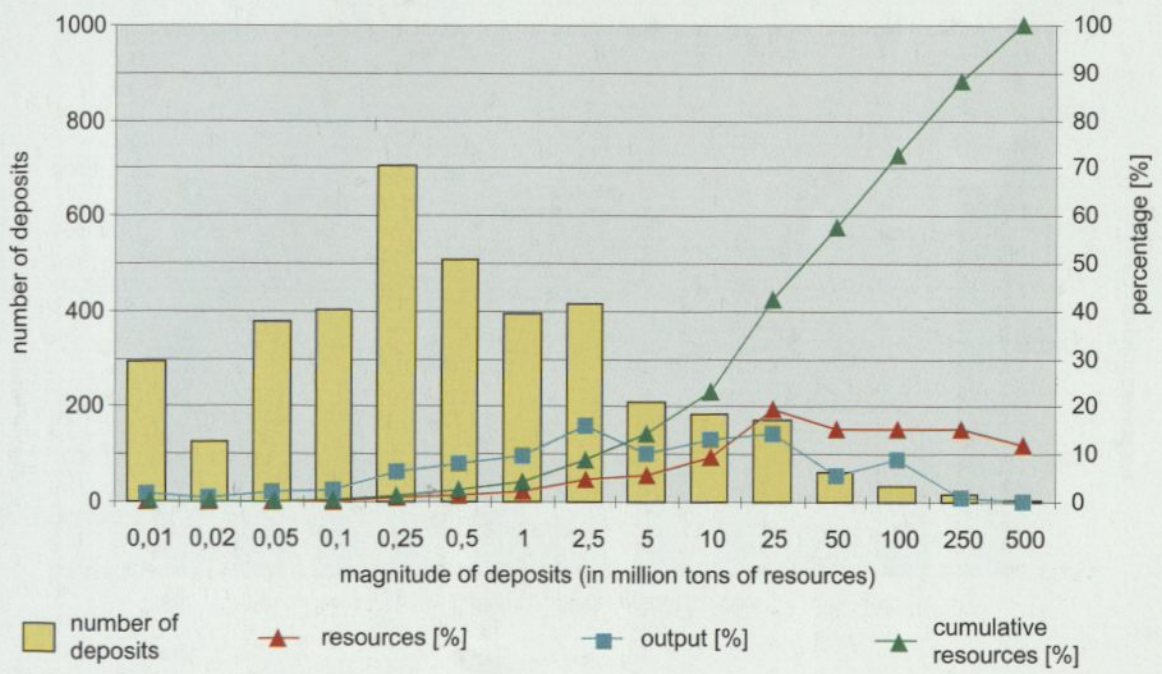
The richest in natural aggregate deposits are voivodeships located along the south-western state border (from Zielona Góra to Nowy Sącz), i.e. in the so-called Sudetic-Carpathian zone. This zone is featured by a large potential and, especially in the Sudetic area, by a good quality of gravels. Deposits of fundamental meaning are those of river origin (terrace sediments of mountain and submountain rivers). In the Sudetic part mainly sand-gravel deposits of Pleistocene lower terraces occur in which crystalline rocks, quartz and sandstones are dominant. The best natural aggregates occur in the Bóbr river region.

In the Carpathian part, the basic constituent of river aggregates is flysch rock, particularly sandstones of poor quality. The main raw material base are deposits occurring in the lower and the upper terraces and also in alluvial cones and in their petrographic content flysch rocks are predominating. The Dunajec river valley is an exception as there occur large quantities of crystalline and calcareous Tatra mountain rocks.

In northern and central Poland - in the Polish Lowland - the most important are deposits of glacial origin (accumulative frontal moraines) and fluvioglacial origin (outwash fans and eskers).

The northern area of the Polish Lowland is characterised by the occurrence of coarse aggregates composed of magmatic rocks of Scandinavian provenance with an admixture of weaker and even detrimental local rocks, such as: limestones, flintstones and siliceous sandstones.

Fig. 32. 2 Frequency of resources magnitude in natural aggregates deposits in Poland



In the central and the southern parts of the Polish Lowland sand deposits with a substantial admixture of sedimentary rocks are prevalent, especially in eastern Poland where sands with a substantial admixture of limestones, marls and gaizes are prevalent which lower the quality of natural aggregates.

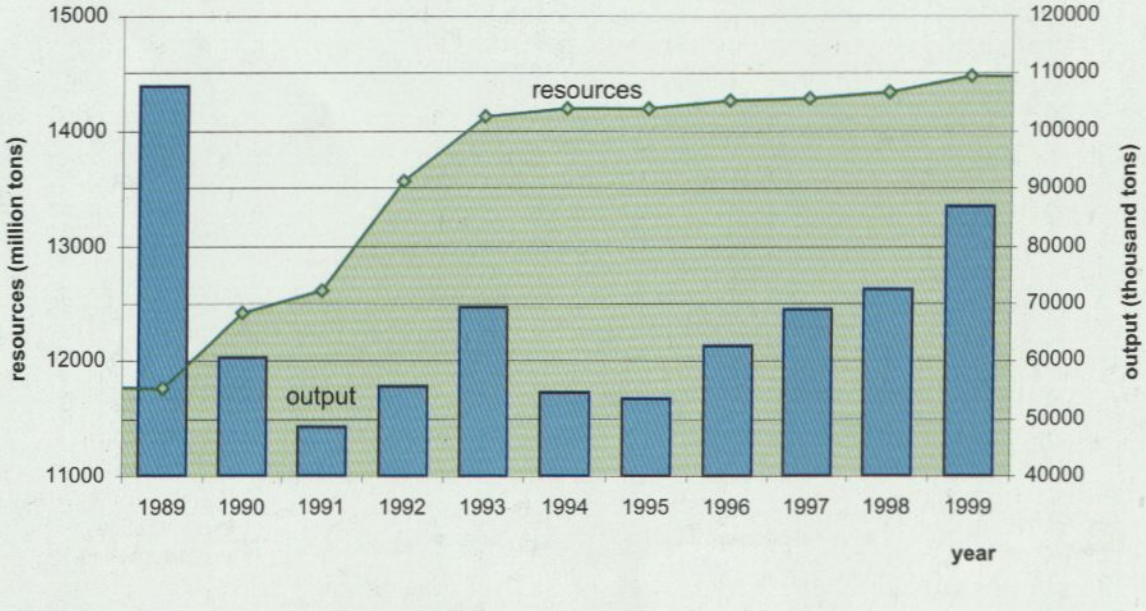
The southern part of the Baltic Sea (Słupsk Shoal) is famous for marine deposits of natural aggregates.

In Poland, there are 1,360 operating pits with total resources of about 3.0 billion tons which constitute 20.7 % of the raw material potential (Table 32.1). The output from the deposits of resources amounting to 1-25 million tons constitutes the largest part (54 %) of the total natural aggregates output (Fig. 32.2).

Table 32.1 Natural aggregates (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**3,915**	**14,464.04**	**5,632.66**	**8,831.38**	**435.21**	**1,995.22**
including reserves of exploited deposits						
Total	1,360	3,005.23	2,517.60	487.63	102.68	1,818.45
including resources of not exploited deposits						
Total	1,577	10,639.50	2,556.34	8,083.16	284.21	167.75
1. Exploration	1,229	2,844.49	2,515.40	329.09	102.58	154.06
2. Prospecting	348	7,795.01	40.94	7,754.07	181.62	13.69
including abandoned deposits						
Total	978	819.30	558.71	260.59	48.32	9.02

Fig. 32. 3 Natural aggregates resources and output in Poland in 1989-99



The aggregate output was diversified in the period between 1989 and 1999 (Fig 32.3) and varied from 46.5 million tons in 1991 to 108 million tons in 1989. The output at the time of the economic transformation in Poland (1990-1999) varied from 60.3 to 87 million tons and now it is about 3/4 of the peak value. This shows the potential which can meet the major demand in future.

In 1999, exports amounted to only 667 thousand tons which constitutes 18 % of the exports in 1995, but as in the previous years the natural aggregates were exported to the same countries: Germany 99.5 % and Czech Republic 0.5 %. Besides, 183 thousand tons (also less than in the last years) of sands, other than siliceous and quartz ones, were exported to those two countries (Germany 59.6 %, Czech Republic 40.2 %).

33. NATURAL GAS

Natural gas fields occur in the Carpathians and in the Carpathian Foredeep as well as in the Polish Lowland: pre-Sudetic and Wielkopolska regions and in the Western Pomerania (Pomorze Zachodnie) (Plate 1). The gas occurs in separate fields or together with oil or oil condensate. About three-fourths of the gas resources are to be found in the Miocene and Rotliegendes sediments which the remaining occur, among others: in the Carboniferous, Zechstein, Jurassic and Cretaceous rocks.

In the Carpathians, gas occurs in the Cretaceous and Triassic rocks, both in separate fields and together with oil fields or oil condensate.

In the Polish Lowland, gas fields occur mainly in the pre-Sudetic and Wielkopolska regions (Permian sediment) as well as in the Western Pomerania (Carboniferous and Permian rocks). The gas has usually a high nitrogen contents (from a dozen or so to over 80 %). There are, however, fields in Zechstein Main Dolomite with a nitrogen contents of 95.7 - 97.6 % and only 3.1 % of methane.

The resources in each region has changed in recent years, which is due to the new gas resources found in the Kościan and BMB deposits in the Polish Lowland. Near two thirds (61 %) of the proven initial resources (in 1999) occurred in Lowland fields. Resources of the Carpathian Foredeep accounted for 38 % of the country resources, while the Carpathian resources for only about 1 %.

The gas of the Carpathian fields is exploited in gas-pressure conditions. It shows a high methane and low nitrogen contents (usually over 80% of methane and on the average a few per cent of nitrogen), the reserves and their exploitation being quite meagre in this region.

In the Carpathian Foredeep, the gas fields occur in the Jurassic, Cretaceous and Miocene sediments. The gas has a high methane and low nitrogen contents (from about 70 % to 98.8 % of methane and 3-22 % of nitrogen). These are structural-lithological, multibedded, sometimes massif fields, occurring in gas-pressure conditions.

In Table 33.1 the recoverable resources/reserves of natural gas are presented, taking into account the degree of geological exploration and management.

Table 33.1 Natural gas (million m^3)

Specification	Number of fields	Extractable Reserves / resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	* **242**	**148,990**	**115,825**	**33,165**	**926**	**77,137**
	** **68**	**15,319**	**11,792**	**3,528**	**666**	**4,823**
	*** **177**	**128,913**	**99,275**	**29,638**	**260**	**67,564**
	**** **6**	**4,758**	**4,758**	**-**	**-**	**4,749**
including reserves of exploited fields						
Total	179	118,649	100,521	18,128	44	77,137
	57	11,335	9,381	1,954	16	4,823
	124	102,557	86,382	16,174	29	67,564
	6	4,758	4,758	-	-	4,749
the Carpathians	34	1,520	875	645	26	892
	23	137	32	105	6	17
	15	1,261	721	541	20	753
	1	122	122	-	-	121
the Carpathian Foredeep	60	53,812	44,324	9,488	1	33,171
	5	164	163	1	1	152
	54	53,109	43,622	9,486	-	32,488
	4	539	539	-	-	530
Polish Lowland	85	63,318	55,323	7, 995	18	43,072
	29	11,033	9,186	1,847	9	4,652
	55	48,187	42,039	6,147	9	34,322
	1	4,098	4,098	-	-	4,097
including resources of not exploited fields						
Total	47	29,438	15,302	14,136	754	-
	5	3,970	2,410	1,560	650	-
	43	25,468	12,893	12,576	104	-
	-	-	-	-	-	-
the Carpathians	2	240	240	-	73	-
	-	-	-	-	-	-
	2	240	240	-	73	-
	-	-	-	-	-	-
the Carpathian Foredeep	13	2,397	478	1,919	3	-
	-	-	-	-	-	-
	13	2,397	478	1,919	3	-
	-	-	-	-	-	-
Polish Lowland	32	26,801	14,584	12,217	678	-
	5	3,970	2,410	1,560	650	-
	28	22,831	12,175	10,657	28	-
	-	-	-	-	-	-

Specification	Number of fields	Extractable Reserves / resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
including abandoned fields						
Total	16	903	1	902	128	-
	6	15	1	14	-	-
	10	888	-	888	128	-
	-	-	-	-	-	-
the Carpathians	3	-	-	-	92	-
	2	-	-	-	-	-
	1	-	-	-	92	-
	-	-	-	-	-	-
the Carpathian Foredeep	3	-	-	-	36	-
	-	-	-	-	-	-
	3	-	-	-	36	-
	-	-	-	-	-	-
Polish Lowland	10	903	1	902	-	-
	4	15	1	14	-	-
	6	888	-	888	-	-
	-	-	-	-	-	-

* total, ** in oil and oil condensate fields, *** in gas fields, **** underground gas stores (PMG)

The recoverable proven resources of natural gas amounted to 148,990 million m^3 (as at 31st December 1999).

The resources of the exploited gas fields amounted to 118,649 million m^3, which constituted 80 % of their total amount. From the total of 242 gas fields 179 fields, are in exploitation (74 %) (Plate 1).

The total economic reserves, amounting to 77,137 million m^3. The total marginal economic resources for the same gas fields amount to 8,973 million m^3.

The fields intended for stores of natural gas have been excluded from exploitation. The reserves left in the gas fields are treated as a gas pillow (buffer capacity) and will not be exploited as long as the stores exist. By the end of 1999, six fields with a total reserve of 4,749 million m^3 had been designated for underground stores. The gas output amounted to 4,322 million m^3 in 1999. The contribution of the particular regions to this output was as follows: the Lowland 60 %, the Carpathian Foredeep 39 %, and the Carpathians only 1 %.

The gas resources and their exploitation in Poland for the period between 1989 and 1999 are shown in Fig 33.1.

In 1999, the gas output covered 43 % of the country's demand. The deficit was balanced by imports which amounted to 5,785 million m^3 (mainly from Russia 80 %). The directions and quantities of gas imports and exports are shown in Table 33.2.

Prognostic gas resources, estimated at about 650 milliard m^3, demonstrate possibility of finding new fields. The most prognostic resources occur in the Polish Lowland 75 %, the Carpathian Foredeep and the Carpathians account for 21 % and 4 %, respectively.

Fig. 33. 1 Natural gas resources and output in Poland in 1989-99

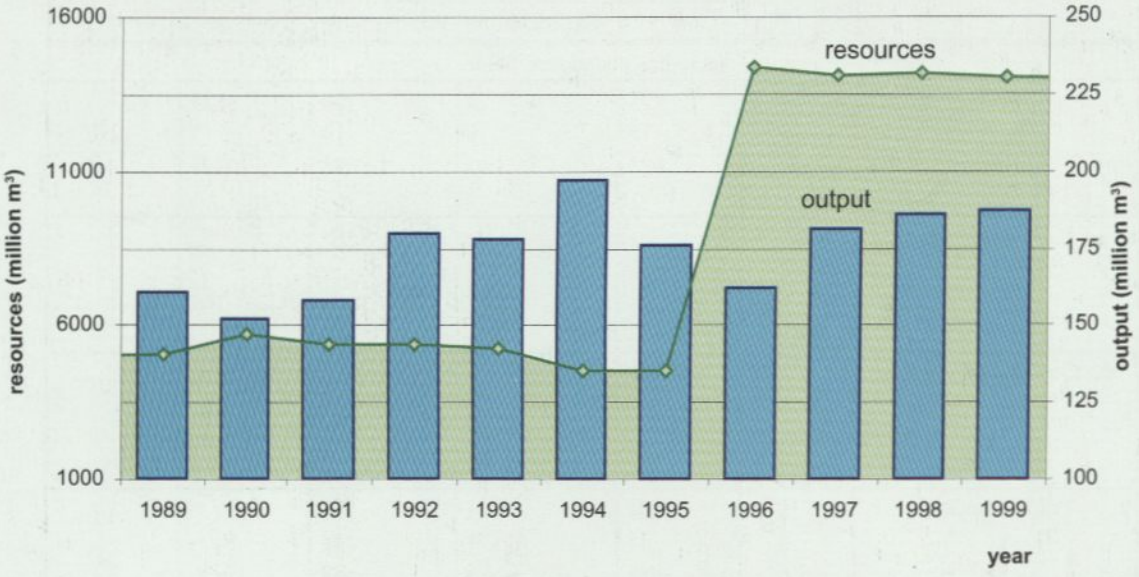


Table 33.2 Directions of Polish imports and exports of natural gas

Import				Export			
	Country	million m^3	thousand PLN		Country	million m^3	thousand PLN
	Total	**5,784.96**	**1,968.802**		**Total**	**29.61**	**10.965**
1	Russia	4, 633.03	1,537.707	1	Germany	29.60	10.937
2	Ukraine	828.56	288.928				
3	Germany	321.56	141.682				

34. NICKEL

Polish nickel ore deposits occur in Lower Silesia (Plate 3). They are deposits of oxide ores of weathering type connected with massifs of the serpentinized basic and ultrabasic rocks. The nickel ores were exploited to 1983, when exploitation of the Szklary deposit was terminated.

The explored in detail intrinsically economic resources of the deposit amounted to 14.6 million tons of ore and 117.0 thousand tons of metal (the average content is 0.8% Ni). In some deposits only with potentially economic ores occur.

Apart from occurring in the weathering types ores nickel accompanies copper ore deposits in the pre-Sudetic monocline (about 44 thousand tons of this metal) and is reclaimed from these ores. Nickel obtained from copper ores amounted in 1999 to 1.72 thousand tons of nickel sulfate.

The exports of nickel amounted in 1999 to 3.2 thousand tons and imports to 2.2 thousand tons (Table 34.1).

Table 34.1 Directions of Polish imports and exports of nickel

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**2.20**	**82,642**		**Total**	**3.24**	**14,174**
1	USA, the	0.40	35,062	1	Czech Rep.	0.66	6,467
2	Russia	0.88	22,784	2	Germany	2.24	2,874
3	Canada	0.32	8,075	3	USA, the	0.03	2,776
4	Germany	0.13	3,632	4	Ukraine	0.05	1,476
5	Norway	0.11	2,816	5	United Kingdom,the	0.02	337
6	Finland	0.15	2,797	6	Macedonia	0.02	115
7	United Kingdom,the	0.04	2,428	7	Austria	0.13	60
8	Netherlands, the	0.04	1,344	8	Bulgaria	0.00	34
9	France	0.04	799	9	Belgium	0.07	16
10	South Africa	0.03	717	10	Switzerland	000	13
11	Switzerland	0.01	517	11	Latvia	0.00	3

35. PEAT

There are three types of peat: fen, high bog and intermediate. Fen peat is the most common in Poland. It occurs in the river valleys and on the lake coasts on the Polish Lowlands. The peat is rich in nutrients and dominated by carex, phragmites and different species of brown moss as well as birch and alder. High bog peat occurs on the watersheds mainly in southern Poland. It is poor in nutrients and dominated by moss, heather, herb plants and pines. Intermediate peat join characteristics of both – fen and high bog peats.

Depending on its physical and chemical properties, peat can be used in the agriculture and gardening as organic fertilizer and for soil structure correcting. It can be used also in the health care

For nearly 50 thousands of peat bogs reconnaissance has been made. Near 18 thousands of them are potentially possible for exploitation, and 800 was or are exploited. The deposits are to be verified.

By 1994, before the new Geological and Mining Law was passed, peat had not been recognized as raw material. It was exploited on permissions given by the Ministry of Agriculture. These permissions are still in force. As a result, our record shows only these deposits, which fulfills the requirements of Geological and Mining Law. There are 91 deposits of peat used for agricultural and gardening purposes, in part of them peat occurs as overburden of lacustrine chalk deposits, and 27 health care peat deposits.

(balneology) for bathing and compresses.

For agricultural purposes, peat pH must be no more than 4. Contents of ash must be maximum 25 %. Peat of a better quality containing no more than 15 % of ash is used for gardening.

Required properties of peat for health care are: consistence of gunk, not frosted and content of water more than 75 %, high contens of active organic compounds and proper microbiological purity.

There is about 1.2 million hectares of peat bogs in Poland (4.2 % of the country`s area). They contain 17 billions cubic meters of peat and concentrate mainly in northern Poland (70 % of peat bogs).

The state of peat reserves and resources and the state of their management are presented in Table 35.1.

Table 35.1 Peat (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**118**	**43.82**	**32.01**	**11.81**	**7.07**	**8.64**
including reserves of exploited deposits						
Total	50	21.61	21.61	-	5.17	7.46
including resources of not exploited deposits						
Total	59	21.54	9.73	11.81	1.90	0.98
1. Exploration	41	9.73	9.73	-	1.90	0.98
2. Prospecting	18	11.81	-	11.81	-	-
including abandoned deposits						
Total	9	0.67	0.67	-	-	0.20

In 1999, exploitation of peat from the deposits shown in this report amounted to 580 thousand tons, including 16 thousand tons of health care peat.

Imports of peat amounted to 20.9 thousand tons, while exports to 47.3 thousand tons.

36. PHOSPHORITES

Phosphorite deposits occur in the north-eastern surrounding of the Holy Cross Mountains (Góry Świętokrzyskie), in the outcrops of Albian sediments (Plate 4).

The thickness of the phosphorite-bearing measures ranges from 0.2 to 4.0 m. The measures hade at a small angle to northern east. They are water containing phosphorite deposits. The percentage of P_2O_5 in the concretions is low and ranges from 13 % to 22 %. The content of the concretions over 2 mm of diameter totals from 280 to 900 kg of phosphorite per 1 m^2 of the whole deposit.

As regards lithology, two types of deposits can be distinguished:

(1) cemented - concentrations cemented by sandy marl,

(2) not cemented - concretions in loose or compact quartz sands with glauconite.

The explored resources of phosphatic concretions amount to 42.4 million tons, which include 7.35 million tons of P_2O_5. At present, the phosphorites deposits are not exploited in Poland and the exploitation will probably not worth in a future.

The whole Polish demand for phosphatic raw materials is met by imports. Imports of phosphorites, phosphate fertilizers and phosphate compounds amounted to 1,533.5 thousand tons in 1999. At the same time, exports of these materials amounted to 109.2 thousand tons.

The magnitude, value and main directions of imports and exports are presented in Table 36.1.

Resources of the prospecting region of the north-eastern surrounding of the Holy Cross Mountains (Salomin-Gościeradów region), estimated at about 21.4 million tons (including 3 million tons of P_2O_5 concretions), can be treated only as reconnaissance mineral resources.

Table 36.1 Directions of Polish imports and exports of phosphorites, phosphate fertilizers and phosphate compounds

	Import				Export		
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Phosphorites						
	Total	**1,528.19**	**296,441**		**Total**	**20.61**	**7,338**
1	Russia	392.35	90,477	1	Czech Rep.	20.21	7,195
2	Morocco	426.67	79,629	2	Uzbekistan	0.39	142
3	Tunisia	448.24	74,075				
4	Togo	141.20	31,027				
5	Algeria	91.55	15,614				
6	India	26.95	4,828				
7	Ukraine	1.18	760				
	Phosphate fertilizers						
	Total	**1.29**	**1,854**		**Total**	**66.38**	**36,467**
1	Germany	1.06	1,092	1	United Kingdom, the	29.93	17,703
2	Denmark	0.09	457	2	Germany	21.81	13,139
3	Israel	0.07	195	3	Czech Rep.	8.92	2,440
4	Italy	0.03	77	4	Denmark	2.35	1,389
5	Sweden	0.03	15	5	Sweden	2.48	1,351
	Phosphate compounds						
	Total	**4.06**	**11,620**		**Total**	**22.26**	**26,853**
1	Germany	0,56	2,196	1	Czech Rep.	12.10	13,733
2	Czech Rep.	0.92	1,955	2	Germany	6.44	6,394
3	France	0.27	1,676	3	Italy	0.97	2,800
4	Lithuania	0.97	1,196	4	Netherlands, the	1.16	1,932
5	United Kingdom,the	0.16	927	5	Denmark	1.12	1,268
6	Belgium	0.14	708	6	Sweden	0.14	135
7	Japan	0.00	523	7	Romania	0.05	108

37. PHYLLITE, QUARTZ AND MICACEOUS SHALES

The raw material from the various metamorphic shales is utilized as a dust carrier of plant protection agents and as a bituminous board dusting agent (phyllite and micaceous shales) and also as a component of refractory mortars (quartzic shales).

In Poland the shale deposits occur in the Sudetes (Plate 7). The total resources of the 4 deposits explored here amount to almost 23.4 million tons. Two of these deposits are in exploitation and their total resources amount to 11.9 million tons and their economic reserves have been estimated at only 7.9 million tons.

The output of shales amounted to 46 thousand tons in 1999, all of them were used as bituminous board dusting agent.

38. POTASSIUM-MAGNESIUM SALTS

Potassium-magnesium salts hare been found in the bedded Zechstein measures, in the Puck Gulf region and in the Kłodawa salt dome (Plate 4).

In the Puck Gulf region, salts of sulfate type (polyrock salts) occur. They form irregular bunches and bands in anhydrite and in rock salt at the depth of 740 m to 900 m. The content of K_2O ranges from 7.7 % to 13.7 %. As yet four deposits have been explored whose total estimated resources amounted to 597 million tons (51 million tons of K_2O).

In the Kłodawa salt dome, salts of chloride-carnallite type occur. They lie along the eastern border of the salt dome and form folded and, in some places, pressed beds, which hide deep at 70 degrees. Carnallite salts are polluted, and the average K_2O content amounts to 8.5 % and that of MgO - 8.1 %. The explored carnallite salt resources in the Kłodawa salt dome amount to 72 million tons.

The state of identification of the resources and management of potassium-magnesium salt deposits are presented in Table 38.1.

Table 38.1 Potassium salt (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**5**	**669.12**	**11.65**	**657.47**	**18.85**	**-**
including reserves of exploited deposits						
Total	1	72.09	11.65	60.44	-	-
including resources of not exploited deposits						
Prospecting	4	597.03	-	597.03	18.85	-

Table 38.2 Directions of Polish imports and exports of potassium-magnesian salts, potassium fertilizers and potassium compounds

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**749.39**	**306,920**		**Total**	**6.23**	**13,386**
1	Belarus	564.54	202,069	1	France	0.68	3,283
2	Germany	99.73	51,403	2	Czech Rep.	2.81	3,074
3	Russia	70.05	31,660	3	Germany	0.45	971
4	Israel	2.40	3,887	4	Netherlands, the	0.23	924
5	Czech Rep.	2.93	3,177	5	United Kingdom, the	0.15	891
6	France	1.43	2,947	6	Slovenia	0.41	742
7	USA, the	0.99	2,020	7	Slovakia	0.36	542
8	Denmark	1.08	1,826	8	Denmark	0.32	542
9	Norway	1.20	1,746	9	Brazil	0.06	378
10	China	0.25	1,186	10	Hungary	0.17	263
11	Malaysia	2.89	1,041	11	USA, the	0.07	169
12	Netherlands, the	0.35	958	12	Bulgaria	0.03	167
13	Chile	0.62	916	13	Belgium	0.06	159
14	Italy	0.27	651	14	Spain	0.02	154

The output of potassium salt in Kłodawa mine amounted to10.9 thousand tons in 1999.

The country's demand for this raw material is met by import. In 1999, 749.4 thousand tons of potassium salts, potassium fertilizers and potassium compounds were imported, and 6.23 thousand tons of the products were exported.

The quantity, value and main directions of exports and imports are presented in Table 38.2.

The total resources of potassium-magnesium salts in Poland in polyhalite and salts of chloride-carnallite type deposits amount to 669 million tons. Two thousand tons of the salts were extracted in 1995 from the Kłodawa deposit.

The country's demand for this raw material is met by import. In 1995, 11.48 thousand tons of potassium salts, 755.6 thousand tons of potassium fertilizers and potassium compounds were imported, and 6.78 thousand tons of the products

39. QUARTZ SANDS FOR PRODUCTION OF CELLULAR CONCRETE AND LIME-SAND BRICK

The following types of sand are used in the whole country for production of cellular concrete and lime-sand brick: pure fine-grained Quaternary sands of glacial and fluvioglacial origin and also fluvial and aeolian sands. The minimum content of silica required for lime-sand bricks amounts to 80 % and for cellular concrete up to 90 %.

The state of identification of the above-mentioned sands is sufficient, and their distribution is fairly uniform in the whole country (apart from the Carpathians) (Plate 8). Qualitatively, the best quartz sands for the cellular concrete and lime-sand brick industries are the fluvioglacial and dune sands. The most suitable raw material are aeolian sands, characterised by a high content of silica, good grain segregation and roundness as well as low contens of foreign matter.

Among the aeolian sands occurring in the country, we distinguish two groups: coastal dune and inland dune sands.

The coastal dunes, occurring in the narrow area along the Baltic shore are not economically used due to their shore protecting function.

The sands of the inland dunes, occurring in a great part of Polish territory are composed mainly (about 70 % of the mass) of the 0.1-0.5 mm fraction.

The total resources of quartz sands used in above-mentioned industry amount to about 399 million m^3 (which is equivalent to 718 million tons of weight). Out of the total quantity, 131 million m^3 (236 million tons) are quartz sands used for cellular concrete and 268 million m^3 (482 million tons) for lime-sand brick production.

The resources of the quartz sands used for production of cellular concrete, and the state of their identification and management are shown in Table 39.1.

Table 39.1 Quartz sands for production of cellular concretes (mnl m^3)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**98**	**267.49**	**136.50**	**130.99**	**6.56**	**48.19**
including reserves of exploited deposits						
Total	38	65.09	63.21	1.88	0.89	48.19
including resources of not exploited deposits						
Total	47	183.08	58.71	124.37	2.10	-
1. Exploration	24	60.14	58.71	1.43	2.10	-
2. Prospecting	23	122.94	-	122.94	-	-
including abandoned deposits						
Total	13	19.32	14.58	4.74	3.58	-

The resources of quartz sands for cellular concretes production explored in detail amount to 29.9 % of the total resources of the raw material, and 16.2 % of the resources occurring in deposits in exploitation.

The economic reserves calculated for nine deposits amount to 14.2 million m^3.

The magnitude of the output of quartz sands for cellular concrete production, for the last decade (1989-1999) is presented in Fig 39.1. The raw material output amounted to 553 thousand m^3 in 1999.

The resources of quartz sands for lime-sand brick production as well as the state of their identification and management are shown in Table 39.2. The resources explored in detail amount to 51.0 % of the total resources. The exploited represent 24.3 % of the total resources. The economic reserves calculated for 33 deposits amount 48.2 million m^3.

Table 39.2 Quatrz sands for production of lime-sand brick (million m^3)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**57**	**131.18**	**39.26**	**91.92**	**1.35**	**14.18**
including reserves of exploited deposits						
Total	15	21.27	17.01	4.26	-	14.07
including resources of not exploited deposits						
Total	37	106.17	18.51	87.66	0.82	0.11
1. Exploration	13	25.25	18.51	6.74	0.34	0.11
2. Prospecting	24	80.93	-	80.93	0.47	-
including abandoned deposits						
Total	5	3.74	3.74	-	0.53	-

The magnitude of the output of quartz sands for production of lime-sand brick in the last decade is presented in Fig 39.2. In 1999, the output of the raw material amounted to 673 thousand m^3 and was lower than in the preceding years.

With the common occurance of the raw material in Poland (except for the Carpathian region) it seems probable that its resources will increase.

Fig. 39. 1 Resources and output of qartz sands for production of cellular concrete in Poland in 1989-99

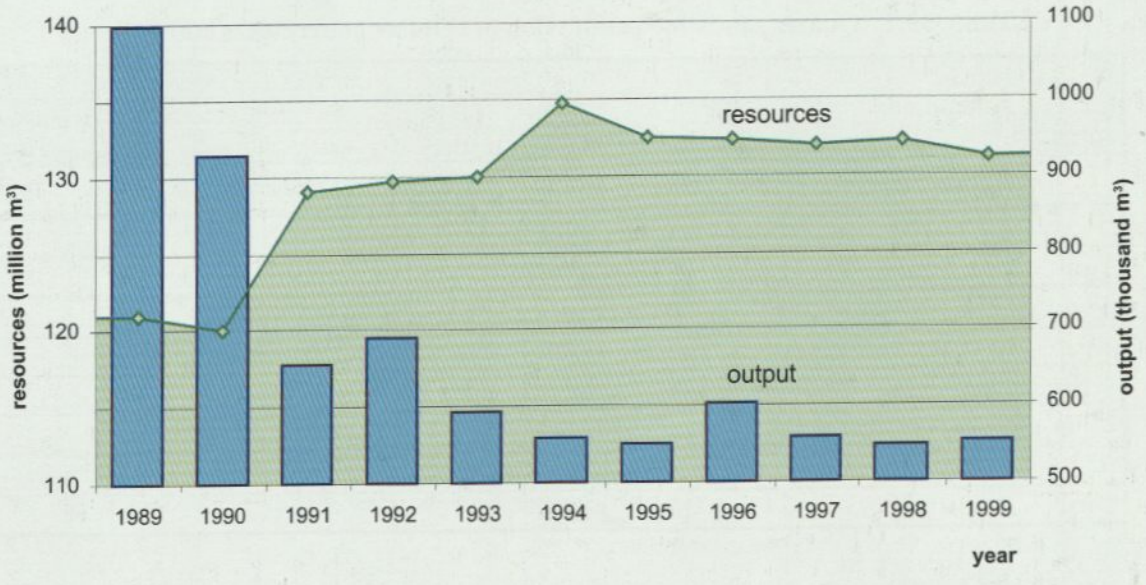
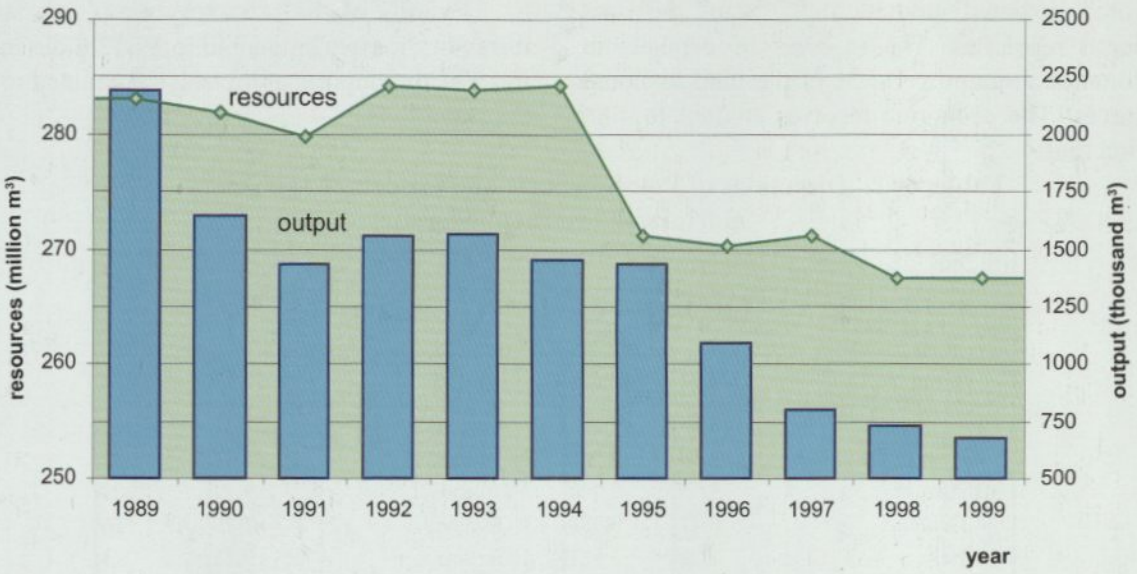


Fig. 39. 2 Resources and output of qartz sands for production of lime-sand brick in Poland in 1989-99



40. REFRACTORY CLAYS

In the industry of refractory materials clays are used which are called, for short, refractory clays. These are kaolin clays of high refractory properties (above 1,500^{0}C) which are used in their natural form as an agent for binding chamotte products and also as the burned clay used for weakening of the mass in the refractory products forming.

The refractory clay deposits occur in the Lower Silesia near Strzegom and in the northern surrounding of the Holy Cross Mountains (Plate 7).

The refractory clay resources and the state of their management are presented in Table 40.1.

Table 40.1 Refractory clays (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**18**	**57.16**	**55.30**	**1.86**	**110.48**	**4.86**
including reserves of exploited deposits						
Total	5	7.68	6.19	1.49	1.02	4.86
including resources of not exploited deposits						
Exploration	6	48.62	48.47	0.15	106.02	-
including abandoned deposits						
Total	7	0.86	0.64	0.22	3.44	-

The resources of the refractory clays amount to 57.2 million tons. The state of identification of these resources is very high. The resources explored in detail amount to 97 % of the total explored resources. The reserves of deposits in exploitation amount to 8.5 % of the total explored resources. The economic reserves amount to 4.86 million tons.

The refractory clays output amounted to 151 thousand tons in 1999 and about 76 % of the total output came from the Rusko-Jaroszów deposit.

Exports of the refractory clays, mortars and refractory masses amounted to 57.17 thousand tons in 1999 and imports of the clays amounted to 46.11 thousand tons.

Table 40.2 Directions of Polish imports and exports of refractory clays, mortars and refractory masses

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**46.11**	**69,600**		**Total**	**57.17**	**13,912**
1	Germany	9.84	27,189	1	Sweden	32.25	5,588
2	United Kingdom,the	2.54	14,042	2	Czech Rep.	9.67	2,632
3	Austria	3.35	9,040	3	Finland	9.39	1,309
4	Belgium	0.47	3,988	4	Germany	2.25	1,156
5	Italy	1.78	3,781	5	Ukraine	0.72	795
6	Sweden	1.90	3,147	6	Belarus	0.31	465
7	Ukraine	23.78	2,802	7	Lithuania	0.55	452
8	Denmark	0.21	1,076	8	Russia	0.29	444
9	France	0.16	866	9	Slovakia	0.60	183
10	Czech Rep.	1.22	842	10	Hungary	0.41	205
11	Netherlands, the	0.15	826	11	Latvia	0.04	123
12	USA, the	0.17	701	12	Kazakhstan	0.10	122

41. REFRACTORY QUARTZITES

In Poland, quartzite deposits suitable for the refractory materials industry occur in the Lower Silesia and the Holy Cross Mountain regions (Plate 7). In the Lower Silesia, near Bolesławiec, the deposits are Tertiary ones and form unregular banks and lentils. In the Holy Cross Mountains the Cambrian or Devonian quartzites form banks in clays and clay-shales.

The state of resources of refractory quartzites, their identification and management are presented in Table 41.1.

Table 41.1 Quartzites (million tons)

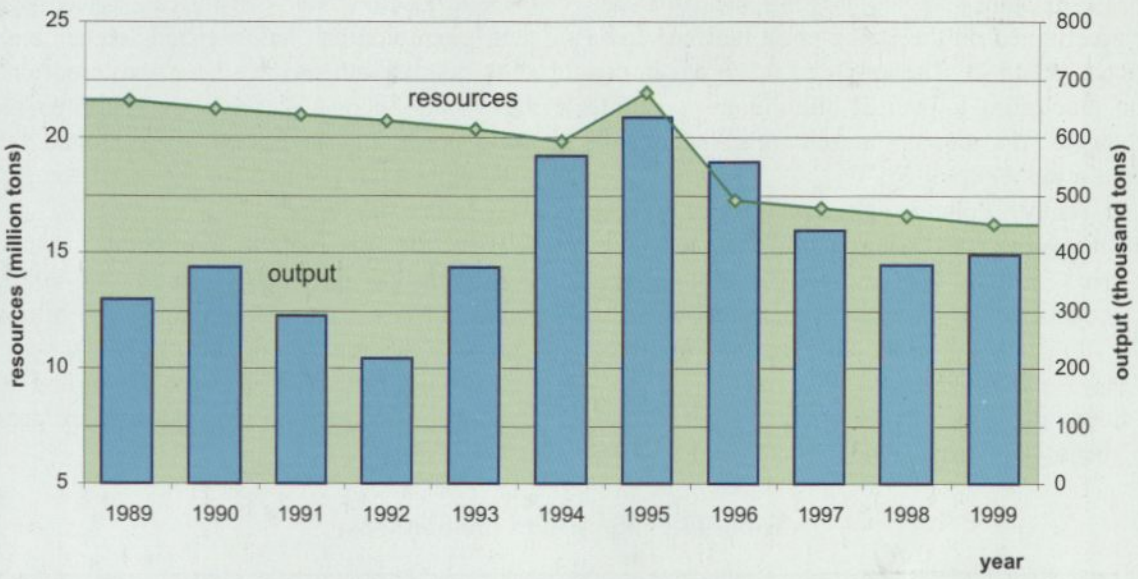
Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**19**	**16.23**	**7.61**	**8.62**	**4.74**	**8.36**
including reserves of exploited deposits						
Total	1	9.35	3.76	5.59	-	8.36
including resources of not exploited deposits						
Total	7	5.95	3.23	2.72	3.84	-
1. Exploration	6	5.25	3.23	2.02	3.84	-
2. Prospecting	1	0.70	-	0.70	-	-
including abandoned deposits						
Total	11	0.94	0.62	0.32	0.90	-

The resources of refractory quartzites amount to 16.2 million tons, of which 9.4 million tons are resources in deposits being exploited which constitute 57.6 % of the total resources of the raw material. The economic reserves amount to 8.4 million tons and relate to the Bukowa Góra deposit only.

Exploitation of the quartzites is conducted in the Bukowa Góra deposit in the Holy Cross Mountain region. It amounted to 396 thousand tons in 1999 (Fig. 41.1)

Export of quartzites amounted to 80 thousand tons in 1999.

Fig. 41. 1 Refractory quartzites resources and output in Poland in 1989-99



42. REFRACTORY SHALES

The explored resources of refractory shales occur in hard coal deposits in the Lower Silesia, in Nowa Ruda mine, and in the Upper Silesia in Ziemowit mine (Plate 7). The prospected refractory shale resources were estimated during hard coal exploration in the Siersza deposit as an accompanying raw material. For several years refractory shales have not been exploited.

The state of the resources of the refractory shales are presented in Table 42.1.

Table 42.1 Refractory shales (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**4**	**11.18**	**6.85**	**4.33**	**3.57**	-
including resources of not exploited deposits						
Exploration	1	9.27	5.89	3.38	0.79	-
including abandoned deposits						
Total	3	1.92	0.97	0.95	2.78	-

43. ROCK SALT

Poland has numerous and rich rock salt deposits. Their occurrence is connected with Zechstein and Miocene formations. Zechstein salt deposits occur in northern Poland and in the pre-Sudetic Monocline (bed deposits) as well as in central Poland (dome deposits). The deposits of Miocene salt-bearing formation (tectonic deformed bed deposits) occur in the southern Poland, in the marginal zone of the Carpathian thrust (Plate 4).

The existence of salt-bearing measures has been ascertained on the Baltic coast between Łeba and Puck (Plate 4). The explored resources in this region, amounting to over 21 billion tons constitute 26.3 % of the country's salt reserves. These deposits are not exploited.

In central Poland, salt dome deposits have been discovered and explored, and their resources have been estimated at almost 52 billion tons, which constitutes 65 % of the country resources. In 1999, 100 % of the salt sold on the domestic market was exploited there.

Some deposits, in the southern salt region, have been exploited since the Middle Ages (Wieliczka-Bochnia - historical notes regarding their exploitation has existed since the 12th century), but others have been explored since the end of the Second World War. The latter reached the deposits and have not been exploited yet. The southern region account for 5.4 % of the explored rock salt resources.

In the pre-Sudetic monocline (Monoklina Przedsudecka), only one explored rock salt deposit exists, and its resources amount to 2.9 billion tons (3.6 % of the total resources in Poland).

Actual resources of the rock salt and state of their identification and management are presented in Table 43.1.

Table 43.1 Rock salt (million tons)

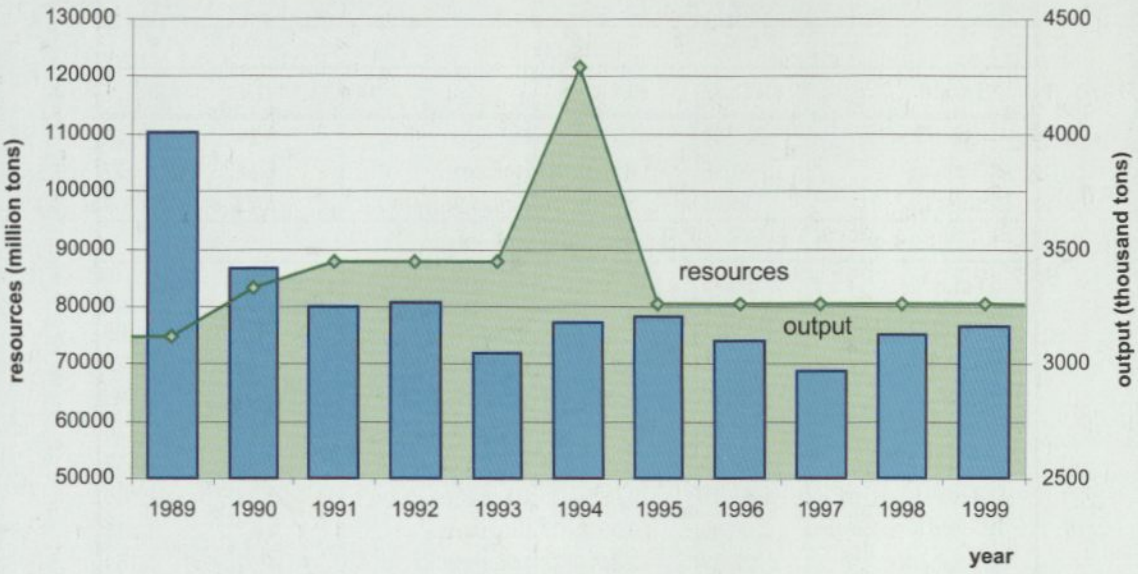
Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**20**	**80,201**	**41,347**	**38,853**	**24,018**	**7,383**
including reserves of exploited deposits						
Total	4	8,463	4,496	3,967	3,374	7,383
including resources of not exploited deposits						
Total	12	71,735	36,849	34,886	20,482	-
1. Exploration	5	27,540	25,889	1,651	10,017	-
2. Prospecting	7	44,195	10,960	33,235	10,465	-
including abandoned deposits						
Total	3	2	2	-	161	-

The output amounted to 3.16 million tons in 1999. The exploitation of Wieliczka Mine was abandoned in July 1996.

Actually, six salt mines are in operation, including the only one that is a shaft mine (Kłodawa) exploiting dry salt suitable for alimentary purposes.

In Fig 43.1, the rock salt resources and output in Poland in 1989-99 are presented.

Fig. 43. 1 Rock salt resources and output in Poland in 1989-99



The exports amounted to 337.7 thousand tons of industrial rock salt, alimentary salt and brine, and to 730.3 thousand tons of sodium compounds in 1999. At the same time, a total of 116.45 thousand tons of industrial salt, food salt and brine were sold abroad. Imports of the sodium compounds amounted to 110.75 thousand tons.

Quantity, value and main directions of imports are presented in Table 43.2 while exports in Table 43.3.

Table 43.2 Directions of Polish import of halite and sodium compounds

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Halite							
	Total	**116.45**	**12,511**				
1	Belarus	88.61	7,497	3	Ukraine	16.38	1,085
2	Germany	10.72	2,801	4	Austria	0.17	216
Sodium compounds							
	Total	**110.75**	**107,125**				
1	Spain	35.05	16,891	11	Norway	2.13	4,075
2	Sweden	8.62	12,658	12	Czech Rep.	5.70	3,029
3	Finland	5.13	10,171	13	Ukraine	5.28	2,819
4	Hungary	8.25	9,809	14	Belgium	1.84	2,190
5	Germany	5.08	9,693	15	China	3.13	1,736
6	France	3.33	6,920	16	United Kingdom, the	0.71	1,418
7	Austria	11.95	5,798	17	Italy	0.60	1,267
8	Netherlands, the	2.95	5,416	18	Russia	1.60	1,185
9	Turkey	3.73	5,375	19	Slovakia	1.83	669
10	USA, the	3.62	5,321	20	Taiwan	0.02	238

Table 43.3 Directions of Polish export of halite and sodium compounds

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Halite							
	Total	**422.35**	**65,713**				
1	Czech Rep.	312.00	41,780	4	Belgium	8.29	2,311
2	Germany	44.96	10,036	5	Hungary	6.58	1,607
3	Slovakia	36.95	5,342	6	Finland	5.22	1,404
Sodium compounds							
	Total	**730.31**	**372,192**				
1	Czech Rep.	150.79	83,419	21	Belarus	3.84	1,608
2	Germany	108.78	52,471	22	Urugvay	3.08	1,523
3	Sweden	121.08	41,761	23	Spain	2.08	1,505
4	Finland	56.00	25,727	24	Switzerland	2.88	1,476
5	France	57.65	25,711	25	Ivory Coast	1.46	1,452
6	Netherlands, the	31.58	20,017	26	Ghana	1.28	1,300
7	United Kingdom,the	40.90	19,396	27	Lithuania	1.07	1,233
8	Denmark	28.28	12,351	28	Malaysia	1.37	1,159
9	Hungary	21.68	12,309	29	Hongkong	1.28	1,137
10	Romania	8.05	9,882	30	Slovenia	0.76	986
11	Slovakia	20.92	9,455	31	Brazil	0.39	979
12	Norway	10.65	4,850	32	Canada	0.40	903
13	Austria	10.34	4,442	33	Columbia	0.56	802
14	Belgium	6.15	4,435	34	Dominica	1.31	802
15	Ukraine	2.71	4,199	35	Guatemala	0.93	696
16	Argentina	6.62	4,132	36	Venezuela	0.94	662
17	Niger	5.00	3,577	37	Russia	0.87	649
18	Singapore	3.94	3,186	38	Honduras	0.94	555
19	Italy	2.69	2,816	39	Thailand	0.67	534
20	Chile	2.49	1,920	40	Peru	0.51	448

The explored rock salt resources make possible a great salt mining development, mainly as regards the salt dome deposits in central Poland which have not been exploited and bed deposits of the pre-Sudetic monocline (especially in the copper deposits occurrence sites).

44. SAND AND GRAVEL FOR FILTRATION

Separate deposits of sands and gravels used for filtration purposed are to be found in the Pomerania voivodeship and the Silesia voivodeship. The deposits are located at Panoszów and Nowy Dwór and their resources amount to 273 thousand tons. However, they are not exploited.

The demand for the sand and gravel for filtration is entirely kept up with by recovery from the deposit while processing the glass sand in Tomaszów area or the kaolin in Bolesławiec region as well as the natural aggregates in Opole voivodeship.

The sands and gravels for filtration recovered in 1999 amounted to 111 thousand tons, including:

- those obtained from the glass and foundry sands - 21,707 t; and
- those obtained from natural aggregates - 93,383 t.

In addition, in the process of enriching kaolin in the Bolesławiec region, sands used for filtration were recovered which amounted totally to 191,442 tons.

45. SILICEOUS EARTH

Explored deposits of siliceous rock (decalcified gaizes) occur in tectonic troughs on the surrounding of the Holy Cross Mountains (Góry Świętokrzyskie) and in lob forms covered by Oligocene sediments in the Lublin Upland (Wyżyna Lubelska) (Plate 4). Siliceous earth is used, after refinement, among others in the chemical industry as catalyst carrier in the synthesis process, carrier of mineral fertilizers and pesticide suspensions, as component of synthetic moulding sands and for the needs of refinement and filtration.

Siliceous earth occurs at a depth of 35 m, and forms measures the thickness of which exceeds a dozen or so metres. The content of SiO_2 ranges from 84.9 % to 89.4 %, and the content of R_2O_3 from 5.5 to 8.0 % and the bulk weight is 263-580 g/l.

The resources of four deposits of siliceous earth amount to 2.2 million tons, and almost half of them are explored in detail. Since 1991 siliceous rock has not been exploited in Poland. In 1998, the exploitation of several dozen tons started in one, very small deposit.

The resources of siliceous rock, and the state of their identification and management are presented in Table 45.1.

Table 45.1 Siliceous earth (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**5**	**2.22**	**1.09**	**1.13**	**1.01**	**-**
including reserves of exploited deposits						
Total	1	0.01	0.01	-	-	-
including abandoned deposits						
Total	4	2.21	1.08	1.13	1.01	-

High quality siliceous earth is all imported. Imports of siliceous earth, diatomaceous earth, terra cariosa and diatomite amounted to 6.7 thousand tons in 1999. In the same time, 0.3 thousand tons of these materials were exported. The above-mentioned materials were imported mainly from the Western Europe (Iceland, Belgium, Germany) and from the United States.

The utilization of siliceous earth resources of explored deposits is very low. The existing processing plants are capable of producing only the lowest quality product, i.e., insulating meal. At the same time, the demand for refined products from imports is increasing.

The value and main directions of exports and imports of diatomite, siliceous and diato-maceous earth are presented in Table 45.2.

Table 45.2 Directions of Polish imports and exports of diatomites, siliceous and diatomaceous earth

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**6.72**	**12,396**		**Total**	**0.30**	**110**
1	USA, the	4.12	8,140	1	Belarus	0.02	33
2	Iceland	0.59	1,364	2	Ukraine	0.26	32
3	Denmark	0.79	814	3	Lithuania	0.01	24

Perspectives of increasing the resources of siliceous earth exist in the region of Upper Cretaceous outcrops on the western (Małogoszcz - Bełchatów - Sieradz zone) and the north-eastern surroundings of the Holy Cross Mountains and in the Lublin Upland.

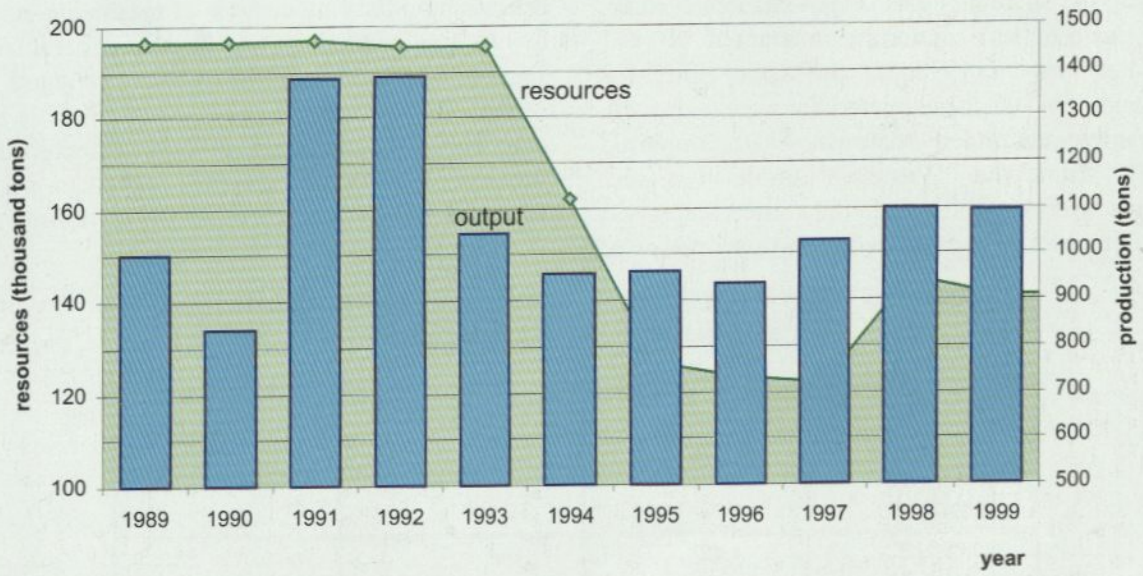
46. SILVER

In Poland, silver does not form individual deposits but coexists with copper ores of the Zechstein formation in the Lower Silesia (Table 46.1). Only a small quantity of silver coexists with lead and zinc in Zn-Pb ores in the Silesia-Cracow region.

Table 46.1 Silver (in thousand tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**14**	**140.88**	**136.47**	**4.42**	**38.05**	**43.55**
including reserves of exploited deposits						
Total	5	80.76	80.76	-	1.75	43.55
including resources of not exploited deposits						
Total	7	57.05	54.23	2.82	35.00	-
1. Exploration	4	54.23	54.23	-	1.42	-
2. Prospecting	3	2.82	-	2.82	33.58	-
including abandoned deposits						
Total	2	3.08	1.47	1.60	1.30	-

Fig. 46. 1 Silver resources and production in Poland in 1989-99



The total resources of silver in Poland are estimated at over 145 thousand tons, of which only 4.1 thousand tons is connected with Zn-Pb ores. The quantity of silver in ores, extracted in 1999, amounted to 1,351 tons (Fig. 46.1) and 1,092.64 tons of silver was extracted from the ores.

Over 90 % of the silver is exported (Table 46.2).

Table 46.2 Directions of Polish imports and exports of silver

Import				Export			
	Country	tons	thousand PLN		Country	tons	thousand PLN
	Total	**34.21**	**6,611**		**Total**	**1,080.31**	**749,051**
1	Germany	16.93	2,517	1	United Kingdom,the	413.09	277,364
2	United Kingdom,the	5.20	2,291	2	Germany	313.72	236,448
3	Czech Rep.	10.81	1,363	3	Belgium	330.00	220,450
4	Italy	0.85	148	4	Switzerland	18.02	11,564
5	Canada	0.20	135	5	Italy	2.57	1,755
6	Netherlands, the	0.16	97	6	Hungary	1.28	862

47. SULFUR

The deposits of sulfur occur in the northern part of the Carpathian Foredeep, in Torton rocks, mainly in gypsum-origin limestones (Plate 4). Sulfur fills small caverns and chaps, and its content in the rock can reaches 70 %, the average is about 25 - 30 %. The concentrations of sulfur are limited to elevated structures formed during the tectonic rebuilding of the foredeep at the end of Badenian. The sulfur accompanying copper, zinc and load ores is of small importance and is used for sulfuric acid production. In 1999, two deposits of native sulfur were exploited using the Frasch metod. Sulfur was exploited likewise the accompanying raw material in three fields of natural gas.

The sulfur resources and their state of identification and management are presented in Table 47.1.

Table 47.1 Sulfur (million tons)

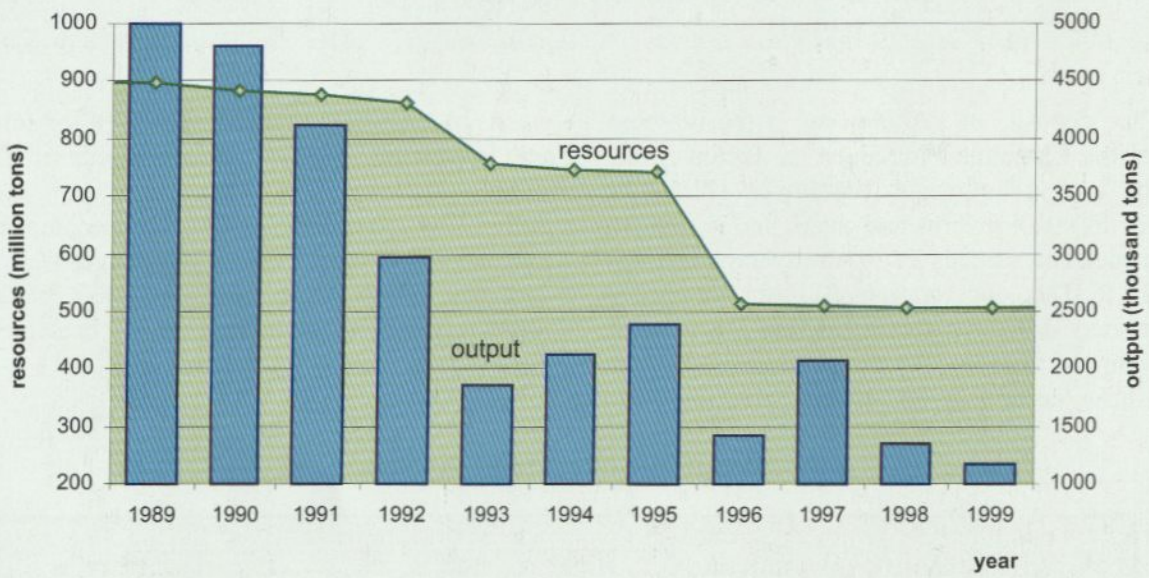
Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**17**	**504.56**	**448.13**	**56.43**	**34.50**	**107.58**
including reserves of exploited deposits						
Total	5	161.24	161.22	0.02	5.28	107.58
including resources of not exploited deposits						
Total	7	198.37	142.84	55.53	8.77	-
1. Exploration	3	100.57	100.57	-	0.01	-
2. Prospecting	4	97.80	42.27	55.53	8.76	-
including abandoned deposits						
Total	5	144.96	144.07	0.89	20.46	-

The resources of native sulfur deposits in the Carpathian Foredeep increased continuously from their discovery in 1953 till 1976. That was the result of intensive identification work which brought new promising discoveries. The most dynamic increase of resources was noted in the years 1965 - 1976. The resources exceeded 1 billion tons in 1976.

In the next years, a gradual decrease of the resources was noted due to the exploitation of the deposits and recently also to the unfavourable situation on international markets. In view of this, the resources of the deposits in inferior exploitational conditions or of the deposits largely exhausted were neglected in the balance. At present the resources of native sulfur amount to 503.8 million tons, excluding 121.0 million tons in protective pillars and 0.7 million tons of sulfur in natural gas fields. The exploitable reserves amount to 21.3 % of the total resources.

The sulfur output increased as dynamically as the resources and reached over 5 million tons in 1980 and maintained that level in the next years. At the beginning of the nineties, a regression began due to the reduction of the prices of sulfur on international markets where cheaper sulfur from desulfurization of bituminous raw materials appeared. The output of native sulfur in Poland was 1,177 thousand tons in 1999, including 3 thousand tons of sulfur from desulfurization of natural gas.

Fig. 47. 1 Sulfur resources and output in Poland in 1989-99



In 1999, exports of sulfur (Table 47.2) amounted to 801 thousand tons. Exports of sulfuric acid and sulfur compounds amounted to 263 thousand tons. In 1999, imports of sulfur compounds and sulfuric acid amounted to 4.6 thousand tons (Table 47.3).

Reconnaissance resources amount to 32 million tons of sulfur and occurr of copper, zinc and lead sulfide ores.

Table 47.2 Directions of Polish export of crude sulfur and refined sulfur

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
Crude sulfur							
	Total	**709.71**	**101,751**				
1	Morocco	372.00	51,089	6	Belgium	30.58	3,683
2	Brazil	91.12	12,511	7	India	26.68	3,498
3	Sweden	51.81	10,298	8	Switzerland	18.05	2,220
4	France	56.30	7,906	9	USA, the	14.32	1,964
5	Czech Rep.	29.60	6,227	10	Italy	13.12	1,714
Refined sulfur							
	Total	**91.64**	**22,348**				
1	Czech Rep.	24.37	5,380	7	Austria	4.79	1,206
2	Ukraine	34.20	4,416	8	Belgium	1.39	906
3	Slovakia	8.42	2,356	9	Germany	0.64	875
4	France	2.68	1,633	10	United Kingdom, the	1.00	635
5	Slovenia	3.97	1,263	11	Croatia	4.70	614
6	Hungary	0.98	1,249	12	Sweden	2.38	435

Table 47.3 Directions of Polish imports and exports of sulfuric acid and sulfur compounds

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**4.60**	**10,819**		**Total**	**263.14**	**14,060**
1	Germany	2.00	3,536	1	Slovakia	39.04	2,561
2	China	0.57	1,820	2	Netherlands, the	77.78	2,115
3	United Kingdom,the	0.20	1,327	3	Czech Rep.	34.58	2,013
4	Italy	0.34	1,208	4	Germany	10.43	1,311
5	Finland	0.02	540	5	Austria	21.02	1,310
6	Czech Rep.	0.25	480	6	Belgium	27.73	1,148
7	Belgium	0.08	330	7	Hungary	11.41	1,120
8	Austria	0.13	321	8	Sweden	7.15	885

48. TIN

Tin occurs in the Sudetes in two deposits: Gierczyn and Krobica (Plate 3).

The resources of the deposits, which were estimated at about 5.5 million tons of ore with an average tin contents of about 0.41 % Sn (e.i. about 22.6 thousand tons), were classified as potentially economic.

The entire Polish demand for tin is satisfied by imports which amounted to 1.18 thousand tons in 1999 (Table 48.1).

Table 48.1 Directions of Polish import of tin

	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**1.180**	**23,935**				
1	China	0.415	9,149	4	Belgium	0.154	3,465
2	Malaysia	0.217	5,027	5	Germany	0.134	1,191
3	Thailand	0.175	3,924	6	United Kingdom,the	0.048	551

49. TITANIUM

The titanium resources are estimated at 97.7 million tons, with an average TiO_2 contents of 7.3 % found in the titanium-magnetite deposits in the Suwałki massif, in the north-eastern Poland (the Krzemianka and Udryń deposits). The deposits are not in exploitation and their economic exploitation does not seem possible because of the big depth of the deposit.

The enire country's demand is met by imports, mainly of titanium ores and their concentrates. Imports amounted to 96 thousand tons and exports (of titanium compounds) to 22 thousand tons in 1999 (Table 49.1).

Table 49.1 Directions of Polish imports and exports of titanium

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**95.9**	**231,446**		**Total**	**21.6**	**138,849**
1	Germany	7.2	58,084	1	Italy	4.2	25,971
2	United Kingdom,the	5.0	38,776	2	France	2.5	15,446
3	Canada	23.6	30,744	3	Sweden	2.0	13,221
4	Norway	49.0	27,453	4	Germany	2.0	12,735
5	Netherlands, the	2.9	21,538	5	USA	1.8	12,571
6	USA, the	1.1	9,209	6	United Kingdom,the	1.6	11,178
7	Spain	1.0	9,174	7	Finland	1.3	8,396
8	Belgium	1.2	9,147	8	Belgium	1.2	7,767
9	Czech Rep.	1.3	8,337	9	Spain	0.9	6,003
10	Italy	0.7	5,448	10	Netherlands, the	0.6	4,311
11	France	0.5	5,020	11	Denmark	0.5	3,439
12	Ukraine	1.3	2,256	12	Greece	0.4	2,673
13	Slovenia	0.3	2,184	13	Jugoslavia	0.4	2,665
14	Finland	0.2	1,813	14	Bulgaria	0.4	2,415
15	South Africa	0.5	1,135	15	Thailand	0.2	1,774
16	Hungary	0.0	401	16	Norway	0.3	1,690
17	China	0.1	252	17	Turkey	0.2	1,511
18	Japan	0.0	237	18	Liban	0.1	1,006
19	Austria	0.0	99	19	India	0.1	796
20	Denmark	0.0	69	20	Romania	0.1	748
21	South Korea	0.0	41	21	Switzerland	0.1	618
22	Australia	0.0	12	22	Belarus	0.1	607

50. VANADIUM

Vanadium occurs in the Zechstein copper ores in the pre-Sudetic Monocline and in the titanium-magnetite deposits (classified as potentially economic) in the Suwałki Massif, in north-eastern Poland.

The resources of vanadium accompanying copper ores amount to about 169 thousand tons. This element is not extracted in the course of processing the copper ore.

In the Suwałki titanium-magnetite deposits an average vanadium contents amounted to less than 0.3 %. The low contents of this metal, big depth of the deposit and environment protection problems connected with possible exploitation make the economic exploitation doubtful.

51. VEIN QUARTZ

Vein quartz finds application in the following industries: metallurgical, refractory materials and ceramic. Its most pure forms are used in the glass, chemical and electrotechnical industries.

In Poland, vein quartz deposits occur in the Sudetes, in the crystal Precambrian and Paleozoic formations (Plate 6). Where they form veins and lentils. Most occurrences have already been explored. The deposits are characterized by varying thickness and big dips of the veins and lentils as well as fluctuating quality of the material.

Table 51.1 Vein quartz (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**7**	**6.84**	**4.69**	**2.15**	**0.35**	**1.95**
including reserves of exploited deposits						
Total	2	4.07	2.21	1.86	0.31	1.95
including resources of not exploited deposits						
Exploration	3	1.83	1.77	0.06	-	-
including abandoned deposits						
Total	2	0.94	0.72	0.22	0.05	-

The state of the intrinsically economic resources of the vein quartz deposits is presented in Table 51.1.

Vein quartz finds application in the following industries: metallurgical, refractory materials and ceramic. Its most pure forms are used in the glass, chemical and electrotechnical industries.

In Poland, vein quartz deposits occur in the Sudetes, in the crystal Precambrian and Paleozoic formations (Plate 6). Where they form veins and lentils. Most occurrences have already been explored. The deposits are characterized by varying thickness and big dips of the veins and lentils as well as fluctuating quality of the material.

52. ZINC AND LEAD ORES

Zinc and lead ores in the Silesia-Cracov region, which connstitutes the northern and north-eastern surrounding of the Upper Silesian Coal Basin (Plate 3), are of industrial importance. The stratabound type deposits are conected with formation of carbonate rocks. The deposits can be found in several regions, i.e. the Bytom, Chrzanów, Olkusz and Zawiercie. However, the Bytom region has only a historical meaning. Exploitation has been conducted there since the Middle Ages and

now only potentially economic ores are left. Actually the exploitation continues in the Chrzanów and Olkusz regions. The deposits in the Zawiercie region have not been exploited yet.

Apart from the deposits in Silesia-Cracow area, some concentrations of zinc and lead accompany copper ores in the pre-Sudetic monocline. They are, however, of little practical importance, though some quantities of lead are extracted from the copper concentrates during their metallurgical processing.

In the Silesia-Cracow region, zinc and lead mineralization occurs in rocks assigned to all periods from Devonian to Jurassic. The region is built of Permian-Mesozoic rocks, which lie monoclinally on the Paleozoic measures. Ores of industrial value are only those connected with the Middle Triassic dolomites and first of all with the so-called ore-bearing dolomites. The ores occur as pseudobeds, horizontal lentils or nests.

Zinc and lead ore resources of the Silesia-Cracow region have undergone great changes for the last fifty years (S. Przeniosło and others 1992). This was due to the fact that on the one hand intensive research was conducted and on the other hand the resources of oxide ores of zinc have been excluded from the country balance (since their processing is a big hazard to the natural environment). The zinc and lead ore resources and the state of their identification and management are shown in Table 52.1.

Table 52.1 Zinc and lead ores (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**20**	* **189.58**	**109.27**	**80.31**	**138.80**	**36.06**
		** ***3.43***	***2.18***	***1.26***	***1.03***	***0.68***
		*** ***7.45***	***4.86***	***2.59***	***3.24***	***1.57***
including reserves of exploited deposits						
Total	3	49.24	48.87	0.37	6.15	36.06
		0.86	*0.84*	*0.02*	*0.06*	*0.68*
		2.07	*2.06*	*0.01*	*0.15*	*1.57*
including resources of not exploited deposits						
Total	13	140.34	60.40	79.94	89.28	-
		2.57	*1.34*	*1.23*	*0.60*	-
		5.39	*2.80*	*2.58*	*1.61*	-
1. Exploration	5	64.93	60.40	4.53	21.55	-
		1.37	*1.34*	*0.03*	*0.15*	-
		2.92	*2.80*	*0.12*	*0.38*	-
2. Prospecting	8	75.41	-	75.41	67.73	-
		1.20	-	*1.20*	*0.44*	-
		2.47	-	*2.47*	*1.24*	-
including abandoned deposits						
Total	4	-	-	-	43.38	-
		-	-	-	*0.37*	-
		-	-	-	*1.48*	-

* ore, ** *metallic lead,* *** *metallic zinc*

The intrinsically economic resources of zinc and lead ores amount to 189.6 million tons and are equivalent to 7.45 million tons of zinc and 3.43 million tons of lead. Over 26 % of ore resources occur in deposits in exploitation (49.2 million tons of the ore). In these deposits, 36.1 million tons of ores with a contents of 1.6 million tons of zinc and 0.68 million tons of lead have been classified as economic reserves.

For the last twenty years or so, the annual output of zinc and lead in Poland has amounted to 4 - 5 million tons of ores, including 140 - 250 thousand tons of zinc (Fig. 52.1) and 40 - 90 thousand tons of lead (Fig. 52.2).

In 1999, the output amounted to 4,919 thousand tons yielding 192 thousand tons of zinc and 83 thousand tons of lead.

The domestic mining industry output of zinc and lead does not met the demand from the processing industry, so the deficit is balanced mainly by imports of concentrates. A considerable part of zinc and lead production is destined for exports. (Table 52.2).

Fig. 52. 1 Zinc and lead ores resources and output in Poland in 1989-99

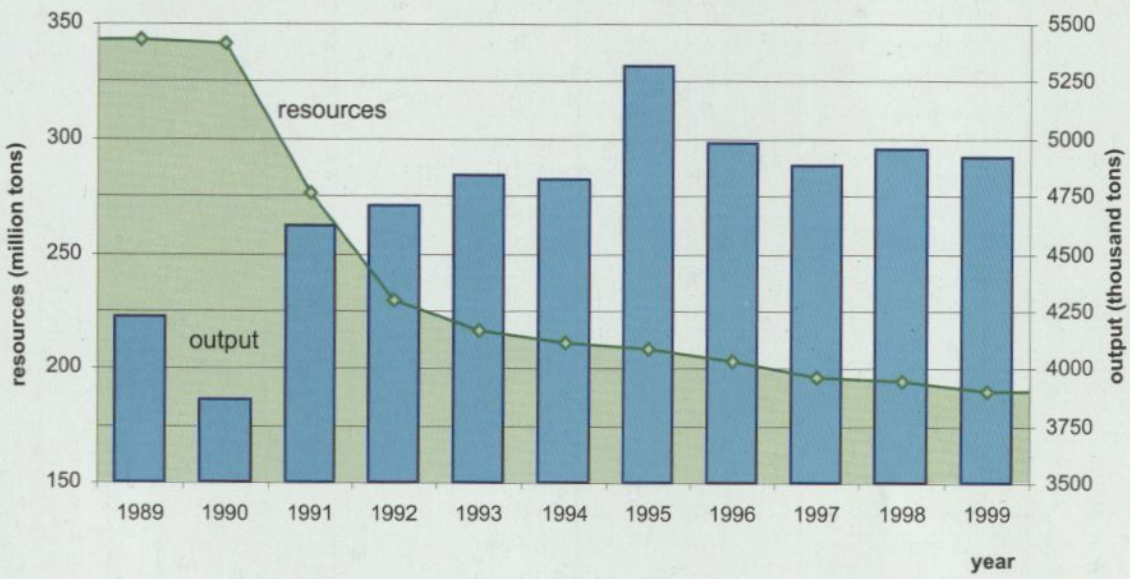


Fig. 52. 2 Zinc resources and output in Poland in 1989-99

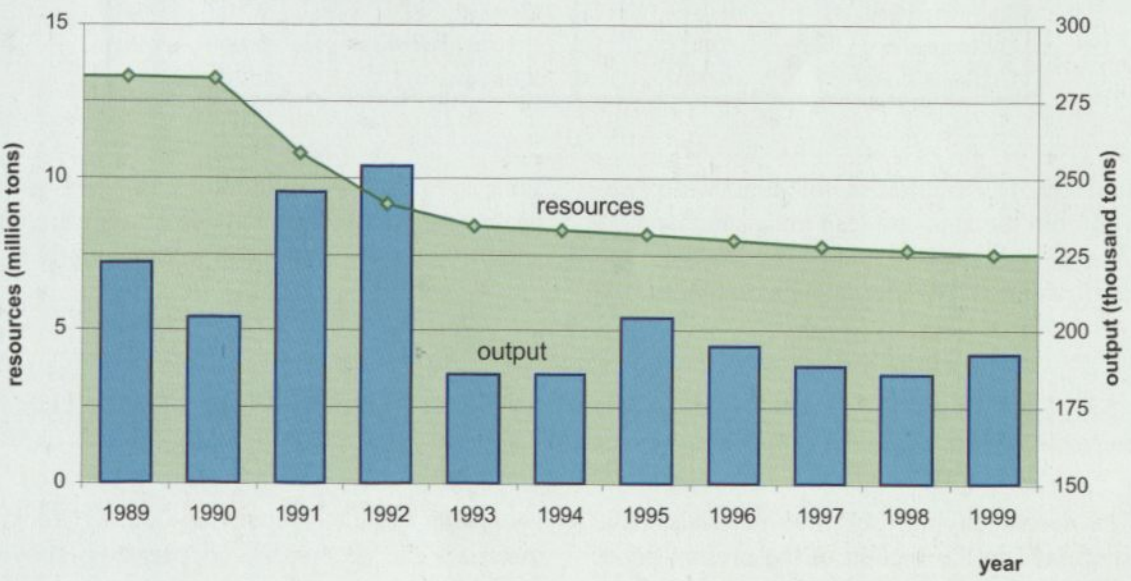


Table 52.2 Directions of Polish imports and exports of zinc

Import				Export			
	Country	thousand tons	thousand PLN		Country	thousand tons	thousand PLN
	Total	**113.18**	**167,755**		**Total**	**129.48**	**446,126**
1	Peru	34.29	36,439	1	USA, the	16.26	60,970
2	Belgium	6.45	34,030	2	Germany	16.01	58,627
3	Australia	22.01	24,916	3	Czech Rep.	14.25	58,085
4	Sweden	13.94	18,984	4	Hungary	10.13	45,667
5	Canada	14.92	14,284	5	Belgium	17.86	42,450
6	Chile	9.11	10,769	6	Slovakia	8.66	36,838
7	Germany	2.81	5,052	7	Italy	5.05	20,930
8	Romania	2.60	3,611	8	India	4.42	16,886
9	Norway	0.61	3,287	9	France	3.83	14,741
10	Turkey	2.54	2,806	10	Norway	8.37	12,896
11	Czech Rep.	1.13	2,593	11	Israel	3.04	11,815
12	China	1.02	2,478	12	Austria	2.49	9,870
13	Finland	0.37	1,945	13	Finland	4.99	7,825
14	Spain	0.40	1,900	14	Singapore	1.89	6,353
15	Italy	0.19	1,218	15	Taiwan	1.42	5,430
16	Bulgaria	0.21	1,072	16	Spain	2.88	4,789
17	United Kingdom,the	0.16	822	17	Bangladesh	1.29	4,775
18	Hungary	0.07	328	18	Ukraine	1.07	4,672
19	Macedonia	0.04	217	19	Switzerlnad	0.96	3,978
20	Netherlands, the	0.04	198	20	Japan	0.90	2,778
21	Russia	0.07	191	21	Togo	0.68	2,750
22	Austria	0.03	179	22	Belarus	0.50	2,538
23	France	0.03	167	23	Sweden	0.38	2,018
24	Ukraine	0.05	79	24	Netherlands, the	0.49	1,720
25	Slovakia	0.06	63	25	Philippines	0.24	1,012
26	India	0.02	61	26	Romania	0.19	846
27	USA, the	0.00	36	27	Slovenia	0.14	686
28	Switzerlnad	0.01	21	28	Russia	0.21	653
29	Denmark	0.00	10	29	United Kingdom,the	0.18	582
30	South Korea	0.00	1	30	Malaysia	0.13	547

In 1999, 180 million m^3 of mine water was removed from the zinc and lead mines and over 33 million m^3 was utilized. This is drinking and industrial water with low mineralization.In the same year, 4.48 milliontons of wastes were generated, 3.28 million tons of which were utilized and the rest were dumped in settling ponds.

53. THE ACCOMPANYING AND WASTE ROCK RAW MATERIALS

The accompanying rock raw materials, have been discussed in the section of the present paper which refer to the individual types of raw materials, irrespective of whether they are the coexisting or accompanying ones. Rock raw materials can accompany copper ores (anhydrite), lignite (ceramics clays, natural aggregate, building ceramic clay and kaolin raw material) and deposits

hard coal (refractory shales, bentonitic raw materials). In some deposits, where the rock material is the main mineral, the accompanying raw material are other rock raw materials such as quartz sands used for lime-sand brick production, foundry sands, building ceramic clay, clay raw material for lightweight aggregate and for cement industry, etc. (also in these cases they have been considered in the section discussing the individual raw materials).

Mineral wastes obtained during exploitation of various raw material deposits can be treated as waste raw materials. They are utilized in engineering works, for road building and reclamation of deformed ground, etc. We do not present the balance and size of the waste on dumps because the waste materials are often deposited on central dumps where they are not registered by the users of deposits.

The total waste rock raw materials produced in 1999 amounted to 68.5 million tons, 30 million tons of which (44 %) were utilized.

54. EXPORTS AND IMPORTS OF MINERAL RAW MATERIALS

Information on the trade turnover in exports and imports of raw materials in Poland are prepared according to Polish Combined Nomenclature (PCN), which is deeply connected with the international classification system named Harmonized Commodity Description and Coding System - HS. This system was accepted in UN as the basic one for the international trade turnovers.

In 1999, summary statistic for minerals and mineral commodities in Poland was presented in three groups: fuels, metals and industrial minerals. The total volume and value of imports-exports of the raw materials as well as for the particular groups of raw materials are presented in Table 54.1.

Table 54.1 Mineral raw material imports and exports in 1999

Group of raw materials	Import Export				Balance	
	Quantity (thousand tons)	%	Value (PLN thousand)	%	Quantity (thousand tons)	Value (PLN thousand)
Total	**42,347** **40,037**	**100.0** **100.0**	**18,126,877** **10,977,134**	**100.0** **100.0**	**-2,310**	**-7,149,743**
Fuels	27,680 29,504	65.4 73.7	12,973,380 5,036,081	71.6 45.9	+1,824	-7,937,300
Metals	8,309 1,563	19.6 3.9	2,855,107 3,806,562	15.8 34.7	-6,746	+951,455
Industrial minerals	6,358 8,970	15.0 22.4	2,298,390 2,134,492	12.7 19.4	2,612	-163,898

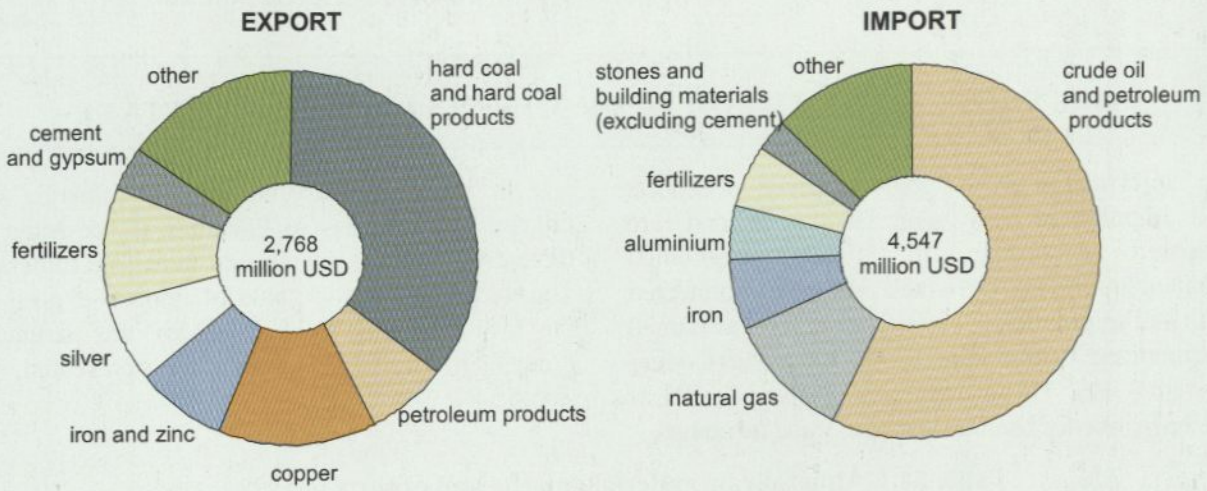
The total value of the exports of raw materials amounted to PLN 10,997 million ($ 2,768 million) in 1999 and was by 2,6 % higher than in the preceding year. The imports value amounted to PLN 18,127 million ($ 4,547 million) and was 19 % higher than those in 1998. The balance of exports-imports turnover was still negative and amounted to PLN 7,150 million in 1999.

The highest values of imports, causing negative balance of the value turnover, related to such raw materials as crude oil (40.35 % of the total import value), petroleum products (17.22 %), natural gas (10.86 %), iron ores (6.12 %) and aluminium ores (4.98 %), phosphoric (2 %) and potassium (1.7 %) raw materials, dimenssion and crushed stones, gypsum and insulating materials (2,99 %).

The most important, as regards the value of exports raw materials in 1999, were: hard coal and coal derivatives (35.34 % of the total import value), raw materials and products of copper metallurgy (13.84 %), silver (6.82 %), nitrogen and multicomponent fertilizers (6.18 %), petroleum products (6.82 %), zinc (4.06 %), salt and sodium compounds (3.99 %), iron and ferroalloys (3.86 %).

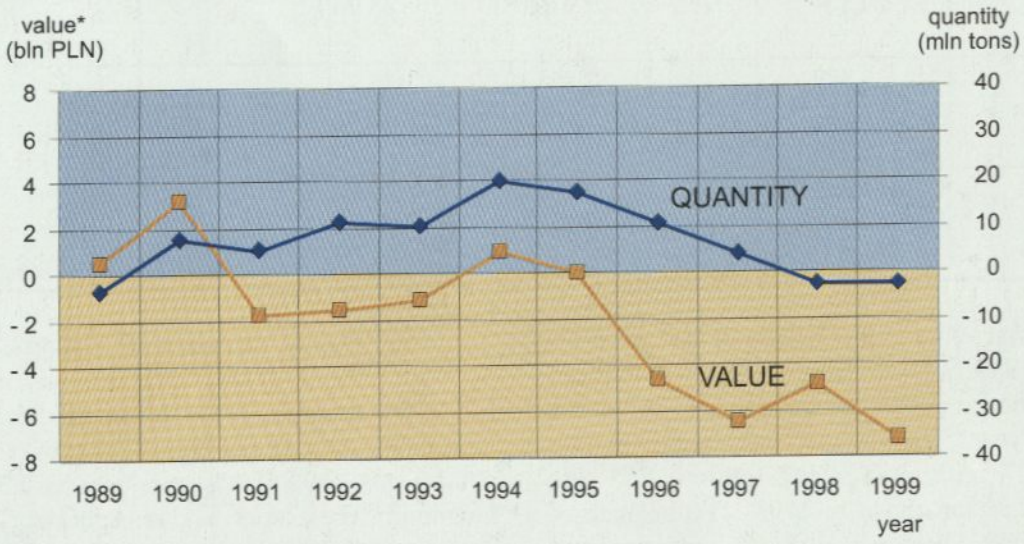
The structure of imports-exports in Poland, i.e. total values and share of various groups of commodities in the international turnover are shown in Fig. 54.1.

Fig. 54.1 The structure of Polish raw materials export and import in 1999



The variation of the imports-exports balance by value and size for the last years is shown in Fig. 54.2.

Fig. 54.2 Balance of Polish imports and exports in terms of value and quantity of mineral raw materials



* fixed prices as of 1999

The percentagecontributions of the particular groups of raw materials to the value of exports in 1995-1999 are presented in Fig. 54.3 and Fig. 54.4.

Fig. 54.3 Contribution of mineral raw materials to the value of Polish exports in per cent in the years 1995-1999.

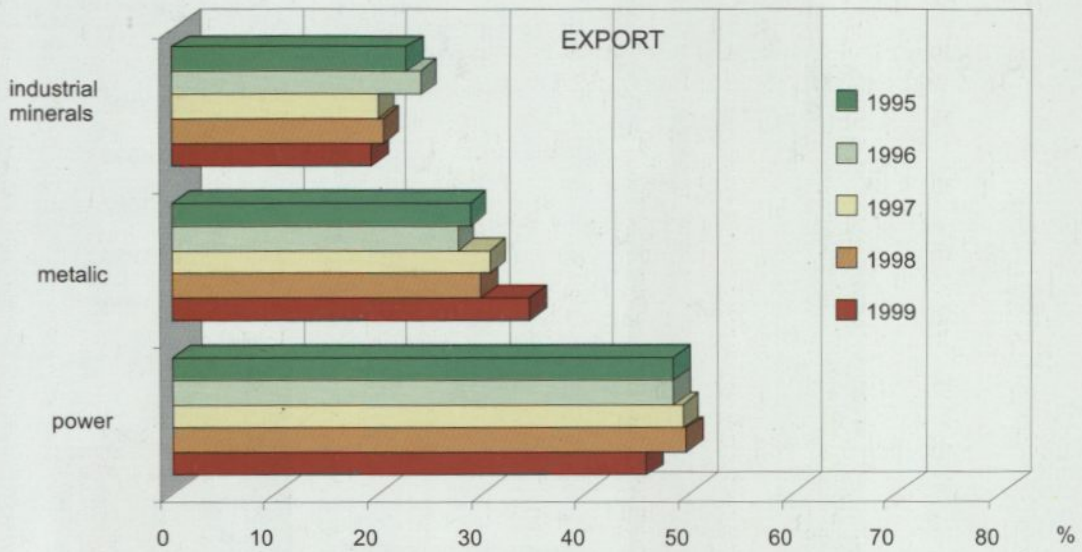
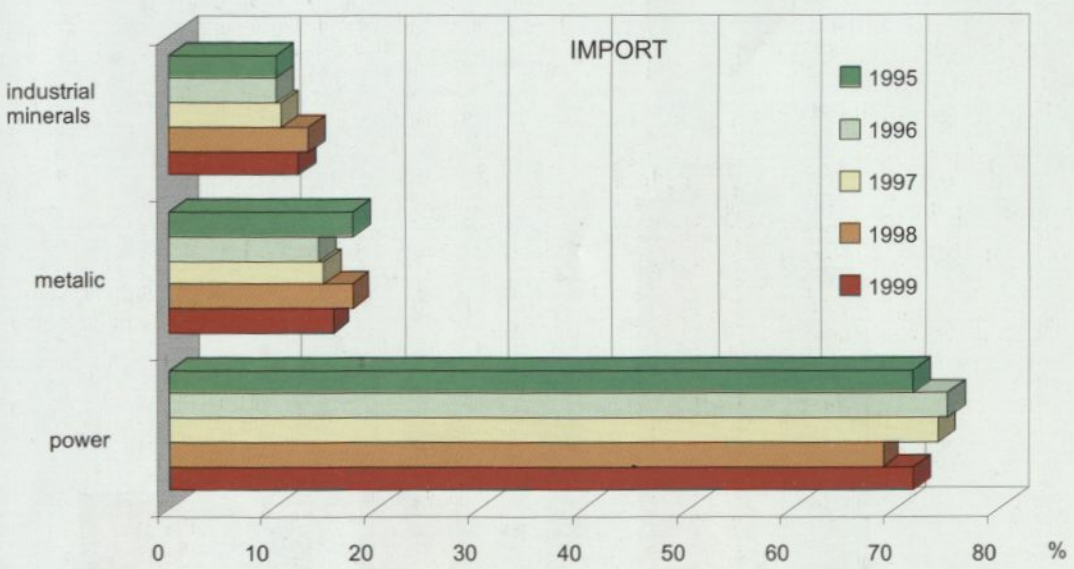
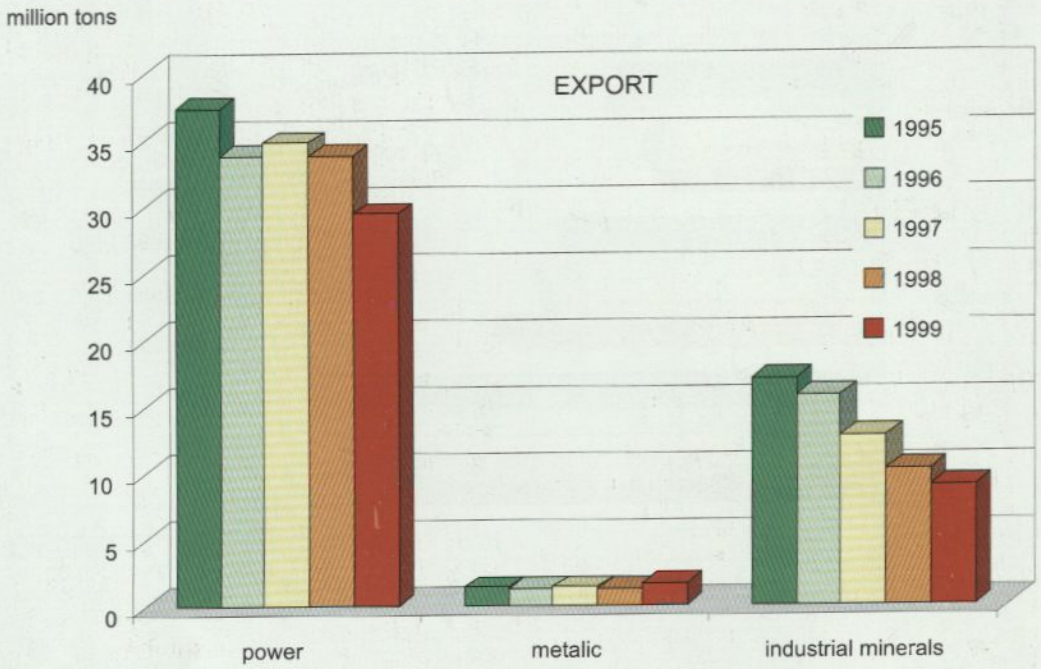


Fig. 54.4 Contribution of mineral raw materials to the value of Polish imports in per cent in the years 1995-1999.



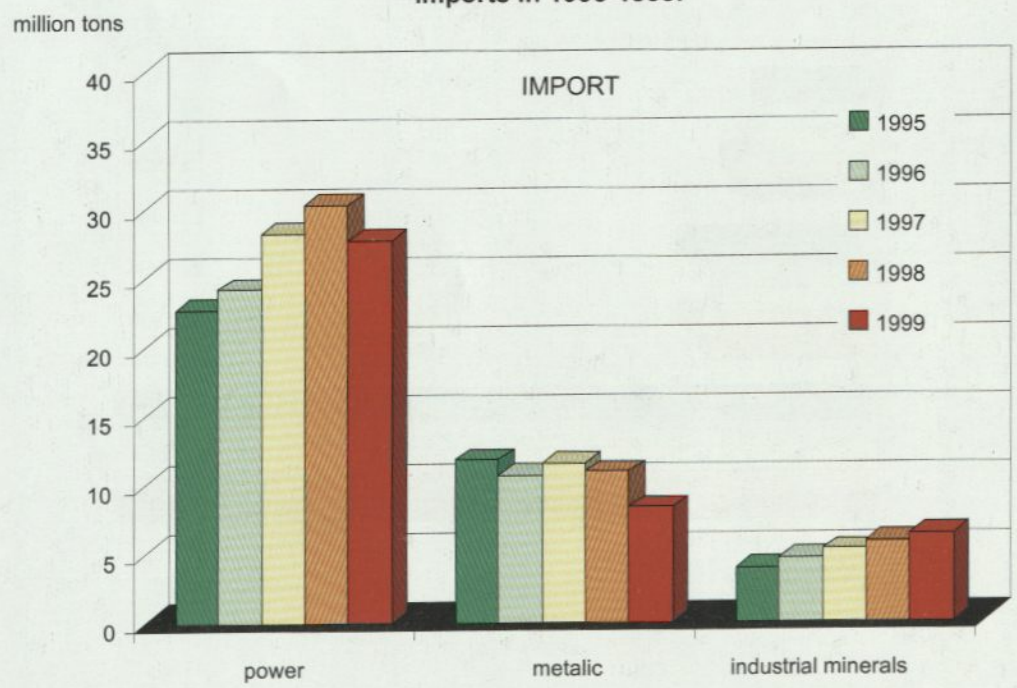
The highest increase of the turnover value (18.8 %) in 1999 with respect to the last year took place in exports of metal raw materials. The highest decrease of the turnover value (5.4 %) were observed in exports of fuels (Fig. 54.3). The import values have been oscillating in all mineral groups in the preceding period of time (Fig. 54.4). The highest increase was noted in imports of fuels and amountedto 42 % in 1996 and 24 % in 1999.

Fig. 54.5 Magnitude of mineral raw material exports in 1995-1999.



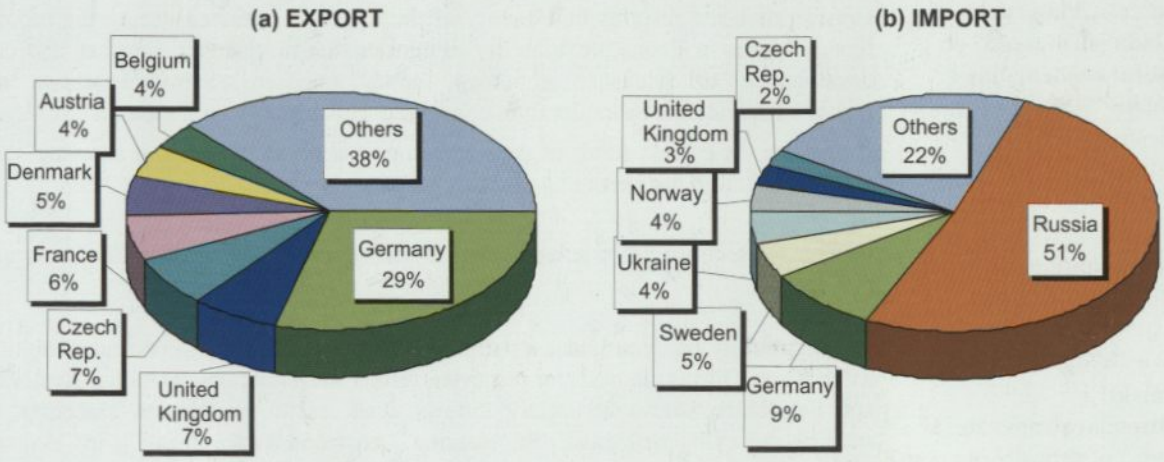
As regards quantity, exports of the fuels as well as the industrial minerals decreased between 1995-1999 (Fig. 54.5). Although in the group of metal raw materials the turnovers are still on the same level.

Fig.54.6 Magnitude of mineral raw material imports in 1995-1999.



The volume of imports of the metal raw materials decreased in the period of 1995-1999. The highest decrease (26.6 %) was noted in 1999. Imports of fuels, increasing between 1995-1998 decreased by 8.4 % only in 1999.

Fig. 54.7 Polish exports (a) and imports (b) of raw materials in 1999, by countries



The major part of imports of the mineral raw materials came from Russia, worth PLN 9,297 million, which constitutes 51.3 % of the total imports value, Germany (9.3 %) and Sweden (4.6 %) (Table 54.7 b).

As regards the value, the highest was exports of raw materials to Germany (29.32 %), lower to the United Kingdom (7.14 %) and to Czech Republic (7.0 %) (Table 54.7 a). The total value of exported raw materials to those countries amounted to PLN 4,771 million, which constitutes 43.5 % of the total value of exports raw materials from Poland.

GLOSSARY

Definition of Stages of Mineability Assessment

Mining Report

(equivalent in Polish mining practice - **„Plan ruchu zakładu górniczego"** or **"Operat ewidencyjny zasobów"** - "Register work of deposit resources")

A Mining Report is understood as the current documentation of the state of development and exploitation of a deposit during its economic life including current mining plans. It is generally made by the operator of the mine. The study takes into consideration the quantity and quality of the minerals extracted during the reporting time, changes in Economic Viability categories due to changes in prices and costs, development of relevant technology, newly imposed environmental or other regulations, and data on exploration conducted concurrently with mining.

It presents the current status of the deposit, providing a detailed and accurate, up-to-date statement on the remaining reserves and resources.

Feasibility Study

document which would be an equivalent to the whole range of Feasibility Study is not prepared

Prefeasibility Study

(**"Projekt zagospodarowania złoża"** - "project of deposit management", but not in the whole)

A Prefeasibility Study provides a preliminary assessment of the Economic Viability of a deposit and forms the basis for justifying further investigations (Detailed Exploration and Feasibility Study). It usually follows a successful exploration campaign, and summarized all geological, engineering, environmental. legal and economic information accumulated to date on the project.

In projects that have reached a relatively advanced stage, the Prefeasibility Study should have error limits of ± 25%. In projects less advanced, higher errors are to be expected. Various terms are in use internationally for Prefeasibility Studies reflecting the actual accuracy level. The data required to achieve this level of accuracy are reserves/resources figures based on Detailed and General Exploration, technological tests at laboratory scale and cost estimates e.g. from catalogues or based on comparable mining operations.

Geological Study

(**"Dokumentacja geologiczna złoża"**)

A Geological Study is an initial evaluation of Economic Viability. This is obtained by applying meaningful cut-off values for grade, thickness, depth, and costs estimated from comparable mining operations.

Economic Viability categories, however, cannot in general be defined from the Geological Study because of the lack of detail necessary for an Economic Viability evaluation. The resource quantities estimated may indicate that the deposit is of intrinsic economic interest, i.e. in the range of economic to potentially economic.

A Geological Study is generally carried out in the following four main stages: Reconnaissance, Prospecting, General Exploration and Detailed Exploration (for definition of each stage see below). The purpose of the Geological Study is to identify mineralization, to establish continuity, quantity, and quality of a mineral deposit, and thereby define an investment opportunity.

Definition of Stages of Geological Study

Reconnaissance

(Penetracja)

A reconnaissance study identifies areas of enhanced mineral potential on a regional scale based primarily on results of regional geological studies, regional geological mapping, indirect methods as well as geological inference and extrapolation. The objective is to identified mineralized areas worthy of further investigation towards deposit identification. Estimates of quantities should only be made if sufficient data are available and when an analogy with know deposits of similar geological character is possible, and then only within an order of magnitude.

Prospecting

(Poszukiwanie)

Prospecting is the systematic process of searching for a mineral deposit by narrowing down areas of promising enhanced mineral potential. The methods utilized are outcrop identification, geological mapping, and indirect methods such as geophysical and geochemical studies. Limited trenching, drilling, and sampling may be carried out. The objective is to identify a deposit which will be the target for further exploration. Estimates of quantities are inferred, based on interpretation of geological, geophysical and geochemical results.

General Exploration

(Rozpoznanie wstępne)

General Exploration involves the initial delineation of an identified deposit. Methods used include surface mapping, widely spaced sampling, trenching and drilling for preliminary evaluation of mineral quantity and quality (including mineralogical tests on laboratory scale if required), and limited interpolation based on indirect methods of investigation. The objective is to establish the main geological features of a deposit, giving a reasonable indication of continuity and providing an initial estimate of size, shape, structure and grade. The degree of accuracy should be sufficient for deciding whether a Detailed Exploration are warranted.

Detailed Exploration

(Rozpoznanie szczegółowe)

Detailled Exploration involves the detailed three-dimensional delineation of a known deposit achieved through sampling, such as from outcrops, trenches, boreholes, shafts and tunnels. Sampling grids are closely spaced such that size, shape, structure, grade, and other relevant characteristic of the deposit are established with a high degree of accuracy. Processing tests involving bulk may be required. A decision whether to conduct a Feasibility Study can be made from the information provided by Detailed Exploration.

Definition of Economic Viability Categories

Economic

(zasoby przemysłowe)

Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a Prefeasibility Study or Mining Report, in order of increasing accuracy, that justify extraction under the technological, economic, environmental and other relevant conditions, realistically assumed at the time of the determination.

The term economic comprises both normal economic and exceptional economic as defined below. These two subcategories are for optional use on a national level.

Normal Economic

Normal economic reserves are reserves that justify extraction under competitive market conditions. Thus, the average value of the commodity mined per year must be such as to satisfy the required return on investment.

Exceptional Economic (conditional economic)

(both terms are not used as yet in Poland)

Exceptional (conditional) economic reserves are reserves which at present are not economic under competitive market conditions. Their exploitation is made possible through government subsidies and/or other supportive measures.

Potentially Economic

(pozabilansowe)

Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a Prefeasibility Study or Mining Report, in order of increasing accuracy, not justifying extraction under the technological, economic, environmental and other relevant conditions, realistically assumed at the time of the determination, but possibly so in the future.

The term potentially economic comprises both marginal and submarginal as defined below.

Marginal Economic **(pozabilansowe grupy "b")**	Marginal economic resources are resources which at the time of determination are not economic, but border on being so. They may become economic in the near future as a result of changes in technological, economic, environmental and other relevant conditions.
Submarginal Economic **(pozabilansowe grupy "a")**	Submarginal economic resources are resources that would require a substantially higher commodity price or a major cost-reducing advanced in technology to render them economic.
Economic to Potentially Economic (Intrinsically Economic) **(bilansowe)**	Quantities, reported in tonnes/volume with grade/quality, estimated by means of a Geological Study to be of intrinsic economic interest. Since the Geological Study includes only a preliminary evaluation of Economic Viability.

Definition of Mineral Reserves and Mineral Resources

A considerable semantic problem exists concerning the meanings of the terms **reserve** and **resource.** The issue is further complicated by the fact that in some languages (and in Polish to) one of the terms reserve or resource does not exist. For this reason the term Total Resource has been introduced.

Total Mineral Resource **(ogólne zasoby bilansowe)**	The Total Mineral Resource is a naturally occurring concentration of mineral raw material in or on the Earth's crust of economic interest and with specified geological certainty.
Mineral Reserve **(zasoby przemysłowe)**	is the economically mineable part of Total Mineral Resource
Remaining Mineral Resource **(zasoby nieprzemysłowe)**	is the balance of the Total Mineral Resources that have not been identified as Reserves.

In accordance with the stage of **Geological Studies** the following subdivisions of Resources are made:

Measured Mineral Resources (**331**) **(A + B)**	Estimated to be intrinsic economic interest based on Detailed Exploration establishing all relevant characteristic of a deposit with a high degree of accuracy
Indicated Mineral Resource (**332**) **(C_1)**	Estimated to be intrinsic economic interest based on General Exploration establishing the main geological features of a deposit providing an initial estimate of size, shape, structure and grade.
Inferred Mineral Resource (**333**) **(C_2)**	Estimated to be intrinsic economic interest based on Prospecting having the objective to identify a deposit. Estimates of quantities are inferred, based on outcrop identification, geological mapping, indirect methods and limited sampling.
Reconnaissance Resource (**334**) **(D_1, D_2)**	Based on Reconnaissance, having the objective to identify a deposit. Estimates of quantities should only be made in sufficient data are available and when an analogy with known deposits of similar geological is possible and then only within an order of magnitude.

POLAND - BASIC INFORMATION

After Concise Statistical Yearbook of Poland, 2000. CSO, Warsaw.

The total area of the country:	312,685 km^2
Length of the national border	3,495 km
with Russia	210 km
with Lithuania	103 km
with Belarus	416 km
with Ukraine	529 km
with Slovakia	541 km
with Czech Rep.	790 km
with Germany	467 km
Sea border	440 km
Population (in 1999)	38,654,000

The administrative division of Poland in 1999:
16 of voivodships,
373 of powiats,
2,489 of gminas.

Currency: zloty (PLN) , exchange rate in the end of 1998 1 USD = 3,50 PLN

Gross domestic product (in 1998):
549,444.5 million PLN

Foreign trade turnover (in 1999):

Imports	45,911.2 million USD
Exports	27,407.4 million USD

Commodity structure of imports and exports (in 1998) in percent, according to the Southern African Customs Union classification:

	Imports	Exports
Agricultural foodstuff goods:	7.0	10.4
Raw materials exluding fuels:	4.1	3.0
Fuels	6.3	5.5
Manufactured goods	43.8	52.7
Machinery and transport equipment	38.8	28.4

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Plate 1

MAP OF OCCURRENCE OF OIL AND GAS FIELDS

Resources:

- Oil fields (0.2 2 mln t)
- Oil and gas fields (0.2 2 10 mln t)
- Gas fields (0.2 2 10 bln m³ mld m³)
- Natural nitrogen gas fields (2 10 bln m³ mld m³)
- Underground gas stores (0.2 2 bln m³ mld m³)
- Areas of prospects for CBM occurrence

Occurrence of oil- and gas-bearing formations:

- Oil- and gas-bearing rocks of the Carpathian Foredeep
- Oil- and gas-bearing rocks of Carpathian area
- Permian (Zechstein) oil- and gas-bearing formations
- Carboniferous oil- and gas-bearing formations
- Pre-Carboniferous oil- and gas-bearing formations
- Areas without prospects for oil and gas occurring (after S. Depowski and others 1993)
- Boundary of Zechstein formation (after R. Wagner)

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0 50 100 km

Voivodeship towns
Other towns
State boundaries
Rivers
Reservoirs

Elaboration: S. Przeniosło
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Plate 2

MAP OF OCCURRENCE OF HARD COAL AND LIGNITE DEPOSITS

Hard coal deposits:

- In exploitation
- Not exploited
- D.Z.W. Lower Silesian Coal Basin
- G.Z.W. Upper Silesian Coal Basin
- L.Z.W. Lublin Coal Basin

Lignite deposits:

- In exploitation
- Not exploited

Occurrence of coal-bearing formations:

- Tertiary lignite-bearing formations (after M. Piwocki)
- Carboniferous hard coal-bearing formations
- Areas without prospects for coal and lignite occurrences
- Boundary of occurrence of coal-bearing Carboniferous formation

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Other towns
State boundaries
Rivers
Reservoirs

Elaboration: S. Przeniosło
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Plate 3

MAP OF OCCURRENCE OF METAL RAW MATERIAL DEPOSITS

Copper ore deposits

In exploitation Not exploited

Boundary of the depth of deposit (1250 m below surface)

Zinc and lead ore deposits

In exploitation Not exploited

Not exploited deposits:

- Nickel ore deposits
- Tin ore deposits
- Arsenic and gold ore deposits

Areas of deposits occurrence:

- Tertiary formations of the Carpathian Foredeep
- Carpathian area
- Triassic ore-bearing dolomites
- Other Mesozoic formations
- Permian (Zechstein) formations
- Carboniferous formations
- Paleozoic rocks of Sudetes and the Holy Cross Mountains
- Pre-Cambrian platform formations
- Limit of Kupferschiefer formation
- a b — Boundary of the dolomite-limestone transition zone (a - sure, b - uncertain)
- Limit of the Upper Silesian Coal Basin

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Voivodeship towns over

Other towns

State boundaries

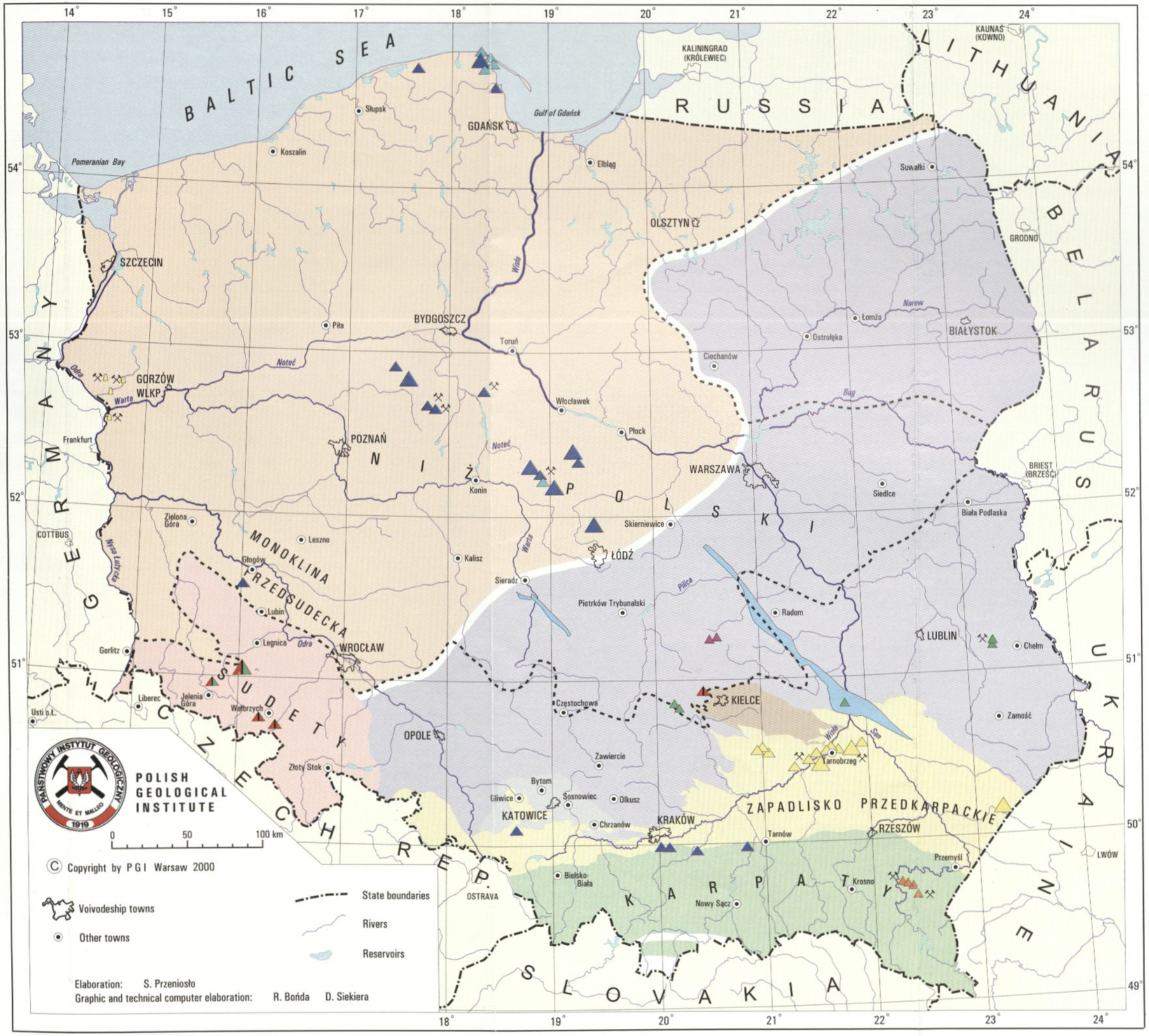
Rivers

Reservoirs

Elaboration: S. Przeniosło
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Plate 4

MAP OF OCCURRENCE OF CHEMICAL RAW MATERIAL DEPOSITS



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Voivodeship towns

Other towns

State boundaries

Rivers

Reservoirs

Elaboration: S. Przeniosło
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Resources:

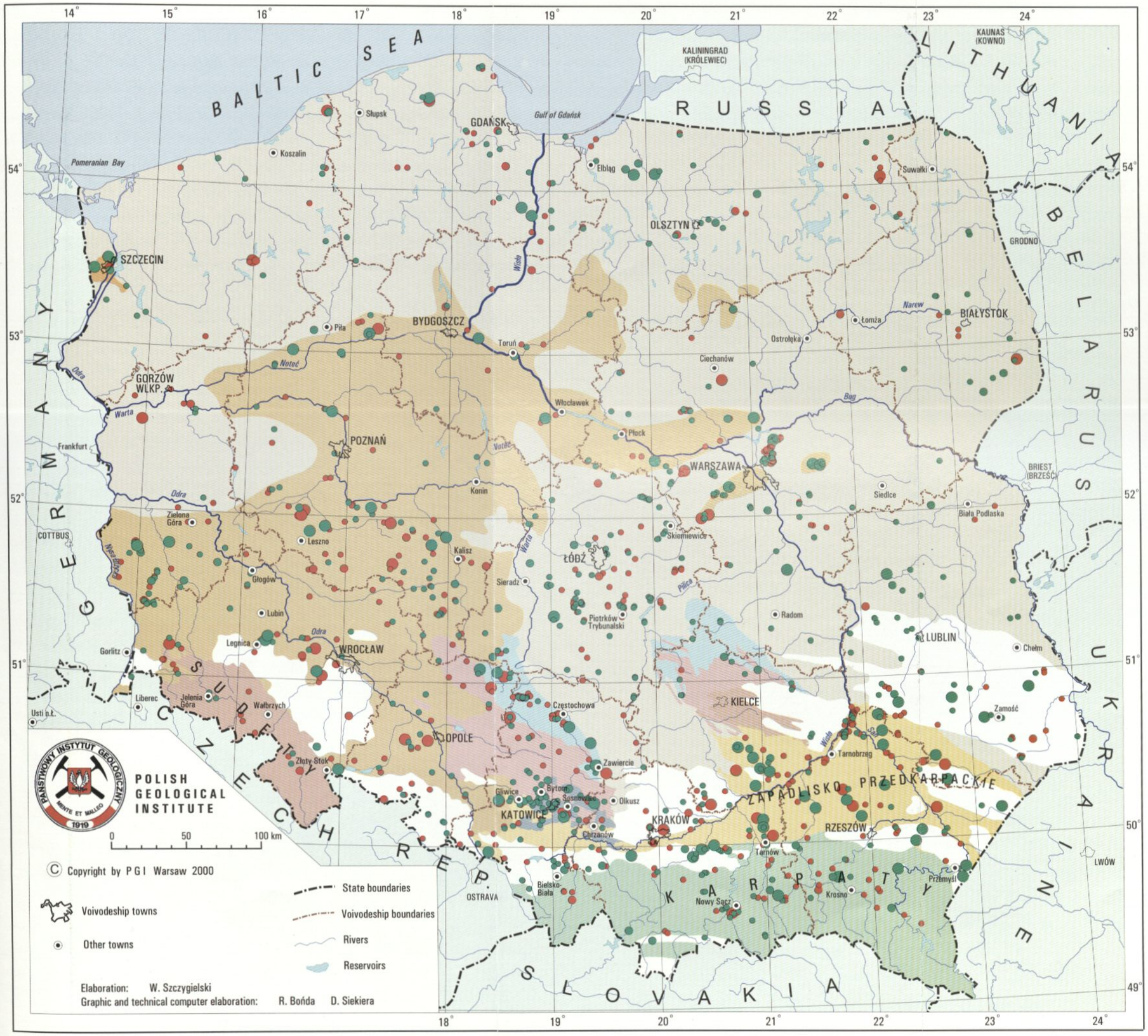
- Native sulfur deposits (100 mln t)
- Sulfur in natural gas fields
- Rock salt deposits (4000 mln t)
- Potassium salt deposits (400 mln t)
- Barite deposits (4 mln t)
- Barite and fluorspar deposits (4 mln t)
- Area of phosphorite occurrence
- Siliceous earth deposits
- Diatomaceous rock deposits
- Deposits of clay raw materials for production of mineral paints
- Deposits in exploitation

Areas of deposits occurrence:

- Tertiary formations of the Carpathian Foredeep
- Carpathian area
- Mesozoic formations
- Permian (Zechstein) formations
- Carboniferous formations
- Paleozoic core of the Holy Cross Mountains
- Crystal rocks of Sudetes
- Boundary of Zechstein formations occurrence
- Boundary of areas of Zechstein and Mesozoic deposits occurrence

Plate 5

MAP OF OCCURRENCE OF RAW MATERIAL DEPOSITS FOR BUILDING CERAMICS



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Voivodeship towns

Other towns

State boundaries

Voivodeship boundaries

Rivers

Reservoirs

Elaboration: W. Szczygielski
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Deposits with resources:

In exploitation	Not exploited
< 1.5 mln m³	< 1.5 mln m³
1.5 - 3 mln m³	1.5 - 3 mln m³
> 3 mln m³	> 3 mln m³

Areas of deposits occurrence:

- Loess and loess loam
- Quaternary (glacial till, clay and marginal lake silt, river aggradations)
- Miocene-pliocene (clays and silts)
- Tertiary of the Carpathian Foredeep (marine clays)
- Oligocene (septarian clay)
- Carpathian flysch (clay-slate)
- Jurassic (claystones and siltstones)
- Triassic (claystones and siltstones)
- Upper Paleozoic (clays and clay-slate)
- Paleozoic rocks of Sudetes and the Holy Cross Mountains (claystones and residual clays)

Plate 6

MAP OF OCCURRENCE OF COMPACT ROCK RAW MATERIALS DEPOSITS

Resources:

- 50 mln t — Dolomites deposits
- 20 mln t — Gypsum and anhydrite deposits
- 1 10 mln t — Chalk deposits
- Vein quartz deposits
- 10 mln t — Feldspar raw materials deposits
- 10 200 mln t — Deposits of limestones and marls for cement industry
- 10 100 mln t — Deposits of limestones and marls for lime industry

Dimensions and crushed stones deposits:

- 10 25 mln t — sedimentary rocks
- 10 25 mln t — metamorphic rocks
- 10 25 mln t — magmatic rocks
- Deposits in exploitation
- Deposits not exploited

Areas of deposits occurrence:

- Quaternary
- Miocene-pliocene
- Tertiary of the Carpathian Foredeep
- Carpathian flysch
- Cretaceous
- Jurassic
- Triassic
- Upper Paleozoic
- Paleozoic rocks of Sudetes and the Holy Cross Mountains

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Other towns
State boundaries
Voivodeship boundaries
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Reservoirs

Elaboration: S. Przeniosło
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Plate 7

MAP OF OCCURRENCE OF CERAMIC AND REFRACTORY RAW MATERIALS DEPOSITS

Resources:

- Bentonitic raw materials deposits
- Ceramic clays deposits (3 mln t)
- Foundry sands deposits (2 20 mln t)
- Kaolin raw materials deposits (10 mln t)
- Magnesites deposits
- Refractory clays deposits (3 mln t)
- Refractory quartzites deposits (1.5 3 mln t)
- Refractory shales deposits (1 5 mln t)
- Shales deposits (5 10 mln t)
- Deposits in exploitation
- Deposits not exploited

Areas of deposits occurrence:

- Quaternary
- Miocene-pliocene
- Tertiary of the Carpathian Foredeep
- Carpathian flysch
- Cretaceous
- Jurassic
- Triassic
- Upper Paleozoic
- Paleozoic rocks of Sudetes and the Holy Cross Mountains

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Other towns
State boundaries
Voivodeship boundaries
Rivers
Reservoirs

Elaboration: S. Przeniosło D. Siekiera
Graphic and technical computer elaboration: R. Bońda

Plate 8

MAP OF OCCURRENCE OF ROCK CLASTIC RAW MATERIAL DEPOSITS

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Voivodeship towns

Other towns

State boundaries

Voivodeship boundaries

Rivers

Reservoirs

Elaboration: A. Piotrowska
Graphic and technical computer elaboration: R. Bońda D. Siekiera

Resources:

1 5 20 mln t — Natural aggregate deposits

2 0 mln t — Glass sands deposits

10 100 mln m³ — Backfilling sands deposits

2 mln t — Quartz sands for production of cellular concrete

2 mln t — Quartz sands for production of lime-sand brick

Deposits in exploitation

Deposits not exploited

Areas of deposit occurrence:

Glacial and fluvioglacial accumulation of the North Poland Glaciation and also fluvial and aeolian ones

Glacial and fluvioglacial accumulation of the Middle Poland Glaciation and also fluvial and aeolian ones

Fluvial accumulation and also area with extraglacial and outwash fan sediments in the Holy Cross Mountains and the Cracow-Częstochowa Jurassic

Fluvial and aeolian accumulation on Cretaceous bedrock

Fluvial and aeolian accumulation of the Carpathian Foredeep

Fluvial accumulation (Carpathians and Sudetes)

Boundary of the North Poland Glaciation

Boundary of the Middle Poland Glaciation