MINISTRY OF THE ENVIRONMENT

MINERAL RESOURCES OF POLAND

POLISH GEOLOGICAL INSTITUTE
WARSAW 2005

Prepared in POLISH GEOLOGICAL INSTITUTE in order
of GEOLOGY DEPARTMENT and GEOLOGICAL CONCESSIONS
of MINISTRY OF THE ENVIRONMENT

Editor: Stanisław PRZENIOSŁO

Prepared by:
H. Chojęta, J. Dyląg, M. Gientka, E. Krystkiewicz, A. Malon,
A. Piotrowska, S. Przeniosło, D. Siekiera, W. Szczygielski, M. Tymiński

Graphics map preparing:
R. Bońda, D. Siekiera

Translated by:
A. Malon, M. Tymiński

Accepted for printing
by prof. dr hab. Leszek MARKS
Director of the Polish Geological Institute
December 2005

Calculations and computer works were done
in the Economic Geology Department of PGI with using the system of
MANAGEMENT AND PROTECTION OF MINERAL RESOURCES IN POLAND "MIDAS"

ISBN 83-7372-854-6

Rakowiecka 4, 00-975 Warsaw
phone: +48 022 8495351 fax: +48 022 8495342 e-mail: pgi@pgi.gov.pl

Wydanie I. Nakład 325. Ark. wyd.: 7.1 Format A4.
Druk zak. w grudniu 2005 r.

Druk Remigraf Sp. z o.o. Zam. nr 9/DS/2005/M

CONTENTS

PLATES

INTRODUCTION

The Polish Geological Institute in the System of Management and Protecting of Polish Mineral Raw Materials MIDAS carries out the registration of data on all of the mineral raw material deposits and resources base and on the output and developing possibilities. The system is a base to carry out the registry of Polish mineral raw materials deposits and to prepare the paper "Bilans zasobów kopalin i wód podziemnych w Polsce" which has been issued annually since 1953. Usually the title of the paper mentioned about is translated as "Balance of Raw Material and Groundwater Resources in Poland" but in the authors opinion this translation should be changed into "Annual Report of Mineral Reserves/Resources and Groundwater Resources in Poland".

The present publication "Mineral Resources of Poland" is based on the Polish paper mentioned about which was published in 2005 (as of 31 December 2004). The paper contains the data on 8.8 thousand deposits with the resources that amounts 193 milliard tons. The chapters referring to the particular Fuels and Mineral Commodities are presented in alphabetical order. The tables concerning the resources, output as well as Polish exports and imports of mineral raw materials have been taken from the Polish edition.

In the last five years the positive hydrocarbons exploration results had a significant impact on the mineral raw material deposits management. The most important were a discovery and an exploitation decision of natural gas fields Brońsko with more than 14,000 million m^3 of economic reserves. At the same time some of the smaller natural gas and crude oil fields were developed. Besides, hard coal and lignite output amounted to 100,000 and 60,000 tons per year accordingly and stabilized. It points out that the energetic raw materials are still very important for Polish extractive industry sector.

A substantial impact on Polish economy have also metallic raw materials as copper, silver, zinc and lead and also the numerous and big deposits of common rock raw materials as raw material base for building, ceramic, lime and cement industries. In the last few years some of chemical raw materials as sulfur, barite and fluorspar lost their magnitude.

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 2004, 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. Przeniosło, 1997; M. Nieć, M. Piwocki, S. Przeniosło, 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 estimation of national raw materials resources based on a geological study stage. The term "Total Resources" covers not only Proved Mineral Resources (in place) and/or Probable Mineral Resources but also Economic Reserves. Economic Reserves separately are specified in a document corresponding to Prefeasibility Study.

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><td rowspan="2">UN International Framework</td><td></td><td>Detailed Exploration</td><td>General Exploration</td><td>Prospecting</td><td>Reconnaissance</td></tr>
<tr><td>Polish System</td><td>Rozpoznanie szczegółowe
(A + B)</td><td>Rozpoznanie wstepne
C_1</td><td>Poszukiwanie
C_2</td><td>Penetracja
D</td></tr>
<tr><td>Feasibility Study and / or Mining Report</td><td>Plan ruchu zakładu górniczego, Operat ewidencyjny zasobów złoża</td><td>1. Proved mineral reserve (Operatywne) (111)
2. Feasibility mineral resource (Nieprzemysłowe) (211)</td><td>usually</td><td rowspan="2">not</td><td rowspan="2">relevant</td></tr>
<tr><td>Prefeasibility Study</td><td>Projekt Zagospodarowania Złoża</td><td>1. Probable mineral reserve (Przemysłowe) (121)
2. Prefeasibility mineral resource (Niezakwalifikowane do przemysłowych) (221)</td><td>(122)
(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 the table has been compiled (Table 1.2), containing Polish classification and UNFC classification of resources/reserves as of 31 December 2004. For oil and natural gas the data are assessed only within the national classification.

The example of adoption of the UNFC classification for two Polish oil/gas fields – Kościan and BMB – was presented during the session of Exports and Supply of Fossil Fuels in Geneva in 10-11 November 2004 (Hoffman M., Przeniosło S., 2004). The formal method of presenting such data regarding to hydrocarbons has not been established yet.

Due to the lack of adequate data the Reserve Base assessed in Poland is bigger than the reserves assessed according to the UNFC by several to dozen percent.

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

Raw material	National classification		UNFC classification	
	Total Resources (Potentially economic excluded)	Including: Economic in situ (Reserve Base)	Reserve	Remaining resources (Potentially economic included)
Backfilling sands	4,600.32	370.31	370.31	5,397.16
Barite	5.66	–	–	–
Bentonites and bentonitic clays	2.73	1.38	1.38	1.60
Building ceramics raw materials	3,972.13	375.48	375.48	3,692.73
Ceramic clays	140.53	8.87	8.87	147.63
Chalk	198.38	16.58	16.58	194.43
Clay raw materials for cement production	219.38	2.01	2.01	263.04
Clay raw materials for light aggregate production	385.36	13.40	13.40	381.16
Copper ores	2,030.67	738.34	738.34	2,179.44
sliver	109.30	43.46	43.46	121.53
copper	39.86	16.97	16.97	37.08
Crude oil*)	19,519.00	16,218.00		
Diatomiceous rock	10.02	0.21	0.21	12.55
Dimension and crushed stones	8,201.85	2,869.92	2,869.92	5,846.18
Dolomites	346.85	133.43	133.43	223.99
Feldspar raw materials	86.84	3.48	3.48	96.54
Flinstones	28.00	–	–	28
Fluorspar	0.54	–	–	–
Foundry sands	349.61	67.52	67.52	288.08
Glass sands	601.40	211.31	211.31	526.86
Gypsum and anhydrites	260.88	115.43	115.43	171.41
Hard coal	42,579.00	6,928.00	6,928.00	63,021.00
Kaolin raw materials	215.20	74.48	74.48	186.77
Lignite	13,634.93	1,586.41	1,586.41	16,664.40
Limestones and marls for cement industry	12,513.54	2,303.94	2,303.94	10,887.24
Limestones and marls for lime industry	5,508.02	942.36	942.36	5,402.15

Raw material	National classification		UNFC classification	
	Total Resources (Potentially economic excluded)		Reserve	Remaining resources (Potentially economic included)
		Including: Economic in situ (Reserve Base)		
Magnesites	13.24	2.80	2.80	12.62
Natural aggregates	14,637.32	2,191.30	2,191.30	12,836.68
Natural gas **)	154,355.00	80,723.00		
Nickel ores	14.64	–	–	–
Peat	76.58	31.27	31.27	53.63
Phyllite, quartz and micaceous shales	23.88	10.80	10.80	-
Potassium-magnesium salts	669.11	–	–	–
Quartz sands for cellular concretes production	241.70	23.67	23.67	221.16
Quartz sands for lime-sand brick production	482.60	57.01	57.01	436.62
Refractory clays	55.64	3.53	3.53	162.45
Refractory quartzites	14.75	7.87	7.87	11.62
Rock salt	80,187.64	4,357.32	4,357.32	99,198.82
Siliceous earth	2.22	–	–	3.22
Sulfur	468.47	33.83	33.83	464.41
Vein quartz	6.59	3.25	3.25	3.69
Zinc and lead ores	174.06	27.89	27.89	295.04
Pb	3.09	0.45	0.45	3.89
Zn	6.75	1.17	1.17	9.28

*) Resources/Reserves extractable in million tons
**) Resources/Reserves extractable in million cubic meters

1. AMBER

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

The biggest accumulations of amber in Paleogene sediments are connected with the northern and southern marginal zone 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 chłapowsko-sambijska delta) and the river from Fennoscandia has transported this material. Now this area lying in the Gdańsk Gulf (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 have been 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 these deposits the resources have been estimated at about 10 tons (B. Kosmowska-Ceranowicz 1995).

The third amber occurrence in Paleogene sediments is the Możdżanowo region near the Słupsk in 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 lies 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 has been explored in detail (I. Olkowicz-Paprocka 1995).

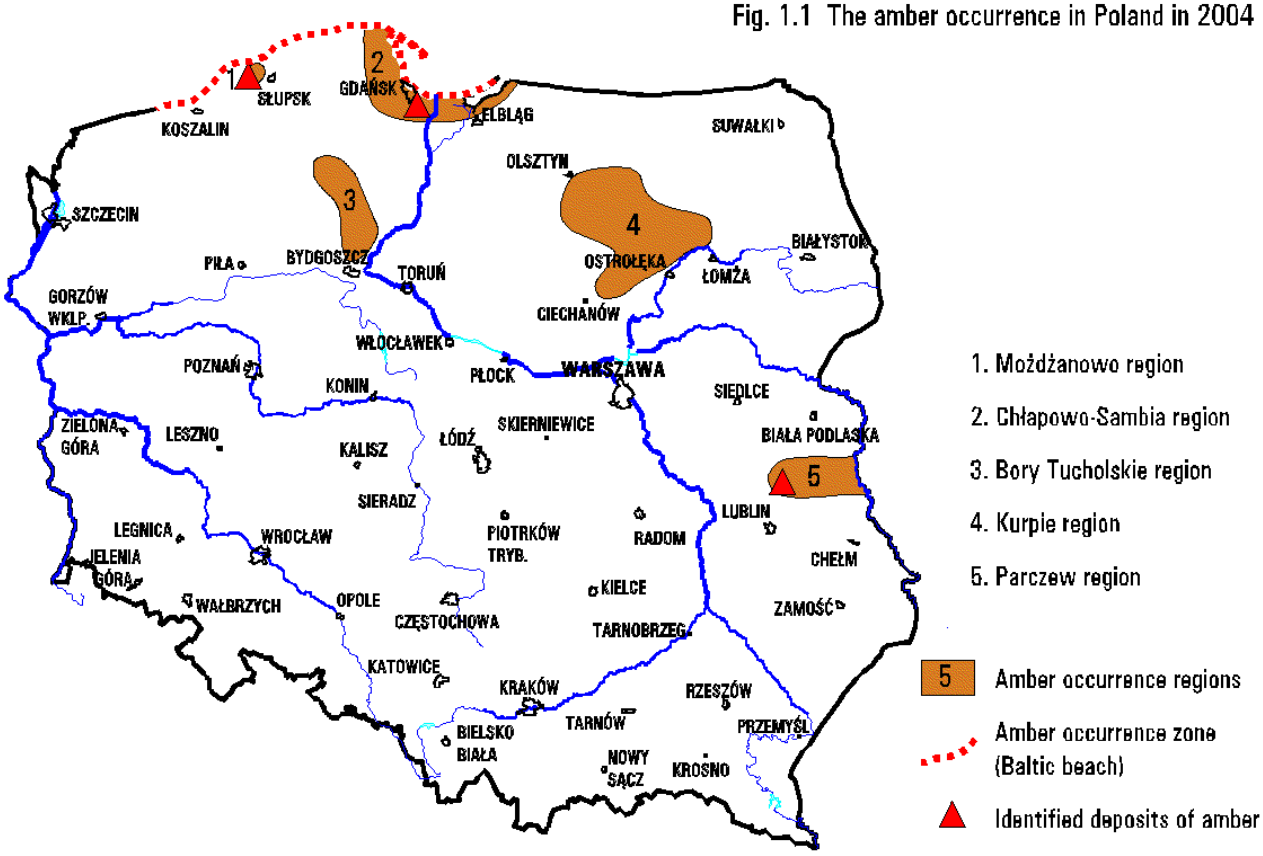
The biggest Quaternary sediments of amber have been accumulated due to the glacier and post-glacial rivers transport from Paleogene sediments (mainly from sediments of the chłapowska-sambijska delta). The greatest amber concentrations were discovered in Kurpie and also in the Bory Tucholskie region where it occurs in the 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. This raw material comes mainly from imports (mostly individual). 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 in 2004



2. ARSENIC

The only arsenic ore deposit in Poland occurs 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 containing 25.5 thousand tons of arsenic. When the exploitation was abandoned 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 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 stowage. It should not exceed 50 km.

In the Upper Silesian Coal Basin (Plate 8) four regions of the backfilling sands occurrence 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 southeastern margin of the Silesia Upland and part of the Racibórz Basin. Sandy-gravel sediments with a thickness of 15 m occur here in the Odra proglacial valley and are connected with the Middle Poland Glaciations.

The northern region includes a 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 fluvioglacial sands occurrence with a thickness of 20-25 m.

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 2,706 million m^3, i.e. 4,600 million tons and decreased by 342.89 million m^3 (i.e. 582.91 million tons) comparing to 1999.

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

Table 3.1 Backfilling sands (million m^3)

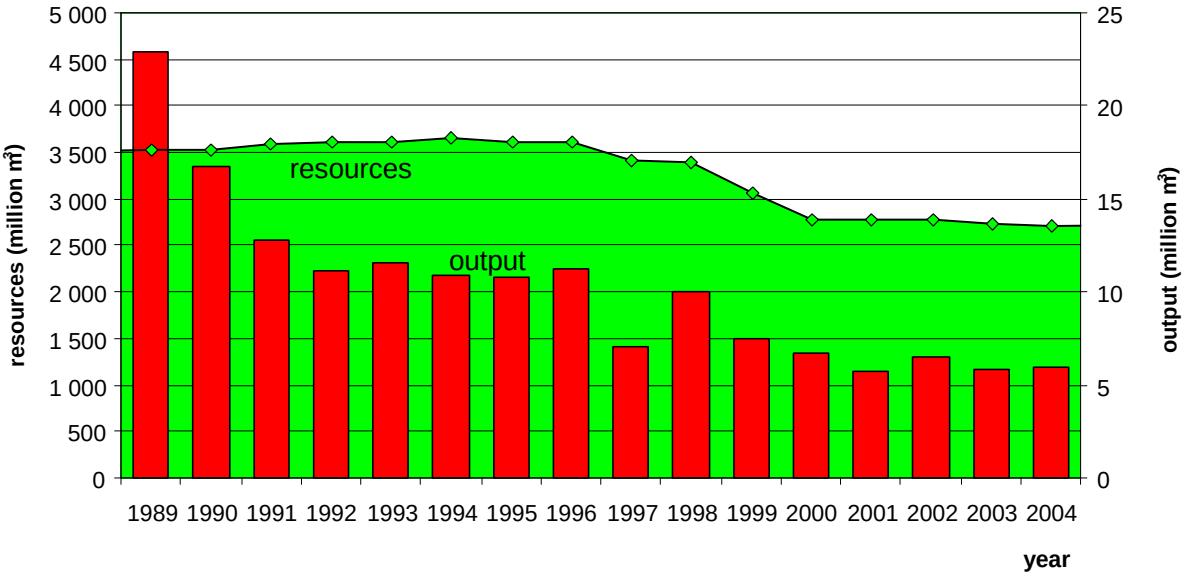
Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**32**	**2,706.07**	**2,125.74**	**580.33**	**686.56**	**217.83**
including reserves of exploited deposits						
Total	10	689.88	543.98	145.90	311.46	217.83
including resources of not exploited deposits						
Total	17	1,838.69	1,414.17	424.52	189.96	-
Exploration	13	1,501.52	1,411.36	90.16	49.91	-
Prospecting	4	337.17	2.82	334.35	140.05	-
including abandoned deposits						
Total	5	177.50	167.59	9.91	185.14	-

The resources explored in detail amount to almost 78 % of the total resources quantity.

The backfilling sands output in the last year amounted to 5,945 thousand m^3 (i.e. 10,106 thousand tons) (Fig. 3.1) and decreased by 1,524 thousand m^3 (i.e. 2,590 thousand tons) comparing to 1999. The mining wastes connected with the backfilling sands exploitation amounted to 162 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 so far.

Fig. 3.1 Backfilling sands resources and output in Poland in 1989-2004



4. BARITE AND FLUORSPAR

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

In Lower Silesia four deposits have been explored, and two of them (Boguszów and Stanisławów) were exploited. Since 1998 barite in Poland isn't exploited.

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 barite occurs in Strawczynek in the Lower Devonian carbonate rocks in the form 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 magnitude of barite resources and present state of their identification and management are presented in Table 4.1.

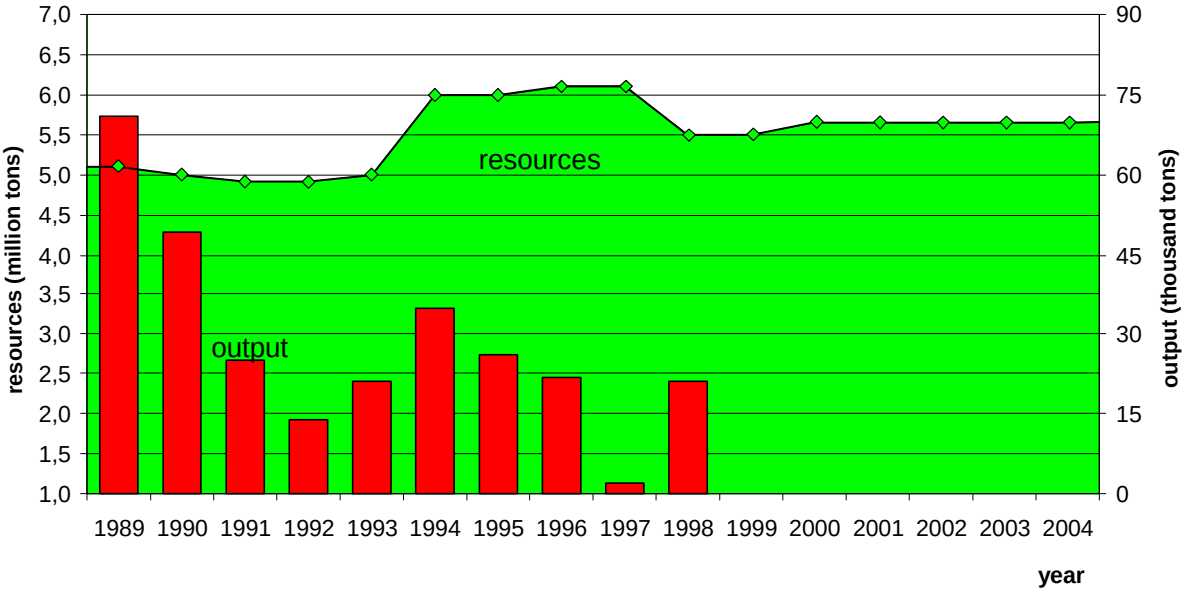
Table 4.1 Barite (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**5**	**5.66**	**1.91**	**3.75**	**0.85**	–
including resources of not exploited deposits						
Prospecting	1	0.36	–	0.36	0.08	–
including abandoned deposits						
Total	4	5.30	1.91	3.39	0.77	–

The resources and output of barite in the period 1989-2004 are presented in Fig 4.1.

In the last years the state of reserves was almost constant amounting to about 5 million tons. An increase of reserves was noted in the period 1993–1995 when they reached the level of 6.3 million tons. From the reason of zeroing of reserves Boguszów's mine after the 1997 flood, reserves of barite decreased to 5.66 million of tons.

Fig. 4.1 Barite resources and output in Poland in 1989-2004



Since 1998 the whole demand for barite and fluorspar in Poland is covered by imports. Imports of barite, witherite and barium compounds amounted in 2004 to 14.72 thousand tons (Table 4.2).

The import of fluorspar and fluorine compounds amounted in 2004 to 9.25 thousand tons. In the same period of time 0.13 thousand tons of barite and barium compounds, as well as 1.26 thousand tons of fluorine compounds were exported.

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

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Barite and barium compounds							
	Total	**14.72**	**16,868**				
1	China	6.94	7,845	3	Slovakia	3.95	2,450
2	Germany	1.52	2,909	4	Czech Rep.	0.44	978
Fluorspar and fluorine compounds							
	Total	**9.25**	**12,739**				
1	Germany	1.92	3,462	4	Holland	0.21	996
2	Mexico	4.64	2,864	5	France	0.19	937
3	Czech Rep.	1.24	1,809	6	Italy	0.20	896

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).

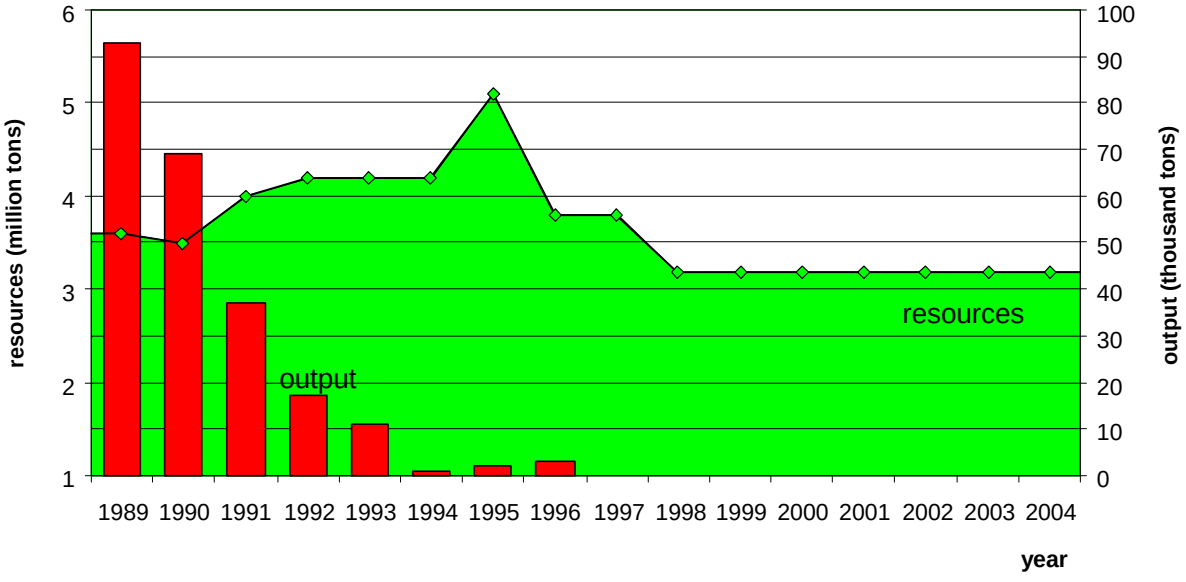
The intrinsically economic resources of bentonite raw materials amount to 2.73 million t.

The state of identification and management of bentonites and bentonitic clay resources are 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	**8**	**2.73**	**1.01**	**1.72**	**0.25**	**1.38**
including reserves of exploited deposits						
Total	1	0.51	0.30	0.21	–	0.51
including resources of not exploited deposits						
Total	4	2.15	0.70	1.45	0.25	0.87
Exploration	2	1.23	0.70	0.53	0.25	0.87
Prospecting	2	0.92	–	0.92	–	–
including abandoned deposits						
Total	3	0.07	0.01	0.06	0.01	–

Fig. 5.1 Bentonites and bentonitic clays resources and output in Poland in 1989-2004



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

Resources and output of bentonitic raw materials in Poland in the years 1989-2004 is presented in Fig 5.1.

Actually only one deposit was periodically exploited (Krzeniów). Last exploitation from this deposit was in 2000.

This decrease is 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. This import amounted in 2004 to 126 thousand tons (Table 5.2).

Table 5.2 Directions of Polish imports and exports of bentonite

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**126.06**	**34,451**		**Total**	1.33	1,319
1	India	28.04	8,385	1	Russia	0.29	379
2	Slovakia	56.14	7,495	2	Czech Rep.	0.32	239
3	USA	10.26	4,924	3	Latvia	0.18	165
4	United Kingdom	3.56	3,628	4	Belarus	0.24	161
5	Italy	9.82	3,154	5	Germany	0.10	100
6	Ukraine	12.10	1,664	6	France	0.06	73
7	Egypt	0.55	1,182	7	Slovakia	0.03	58
8	Hungary	1.74	1,146	8	Lithuania	0.04	49
9	Czech Rep.	1.98	752	9	Finland	0.03	38

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. The main source of building ceramics raw materials is Quaternary and Paleogene sediments, rarely older ones (Table 6.1). 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. Clay sediments older than Paleogene 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 6.2. The resources of building ceramics raw materials totalled at the end of 2004 1,986 million m^3 (equivalent to about 3,972 million tons).

Table 6.1 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	+		+			
		marginal lake clays and silts	+			+	+	
		clays and Elbląg silts	+	+		+	+	
		glacial tills	+					
Paleogene	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 resources of deposits in exploitation amount to 14.4 % of the total resources, the resources in deposits not exploited amount to 73 % (including 11.3 % of resources in deposits explored and 61.7 % in prospected deposits) and the abandoned deposit resources to 12.6 %.

The economic reserves have been estimated as yet for 332 deposits (out of the 343 exploited deposits) and they total 187.74 million m^3 (i.e. about 375.48 million tons), which constitutes 59.5 % of the exploited deposits.

In 2004, the output amounted to 2,732 thousand m^3 (about 5,464 thousand tons) (Fig. 6.1). 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 (Koszalin, Bydgoszcz, Lębork, Olsztyn and Białystok regions).

About 50 % of the exploited raw material is exploited from the Paleogene clays and silts deposits, 30 % from the Quaternary marginal lake clays and silts, 20 % from the Triassic and the Jurassic sediments, and 5 % from other deposits.

Production of the 5 biggest producers of this raw material amounted to 50 % of the total output. Production of the next 15 producers amounted to 30 %. The output of about 300 smaller firms constitutes only 20 % of the total output. The smaller producers usually are active periodically, depending on the market state. Majority of them exploits maximum 5 thousand tons of the raw material per year.

Table 6.2 Building ceramics raw materials (million m^3)

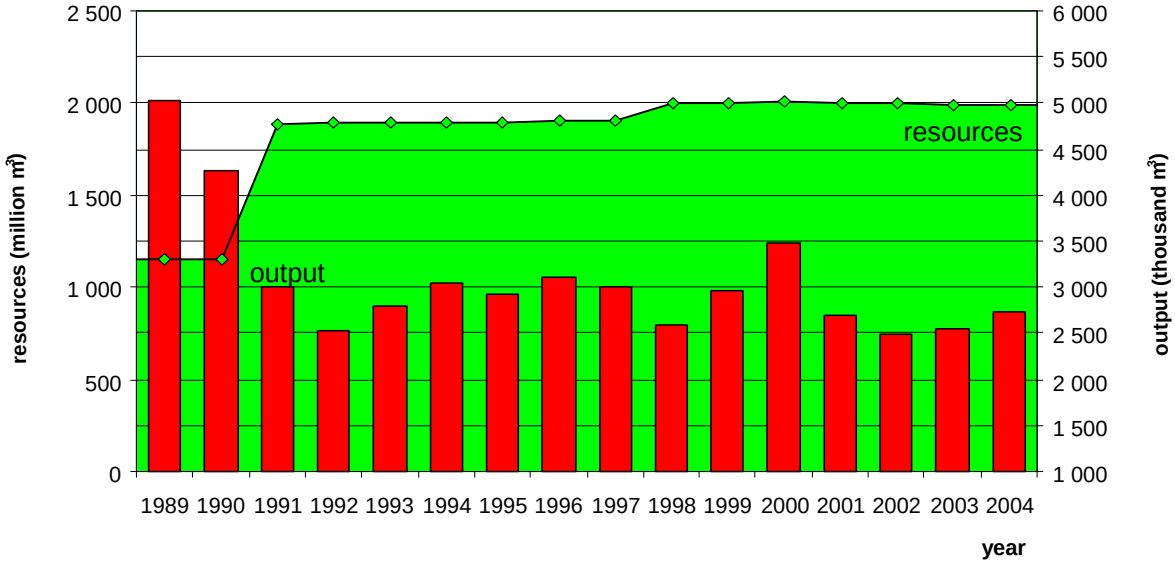
Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**1,212**	**1,986.07**	**632.47**	**1,353.60**	**48.04**	**187.74**
including reserves of exploited deposits						
Total	343	286.01	244.58	41.43	2.60	165.56
including resources of not exploited deposits						
Total	296	1,449.46	168.93	1,280.53	22.46	3.98
Exploration	221	224.16	168.93	55.23	11.74	3.98
Prospecting	75	1,225.29	–	1,225.29	10.72	–
including abandoned deposits						
Total	573	250.60	218.96	31.64	22.98	18.19

The prognostic total resources of building ceramics raw material are estimated at 3,442 million m^3 as of 1st January 1981.

This forecast relates only to resources of clay raw materials suitable for hollow and thin-walled products and light - weight ceramic aggregate ('keramsite'). 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.

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 marginal lake clays and 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 1989-2004



Marginal lake clays and silts will be the most important in voivodeships with a reserves deficit and difficulties with increasing the reserves. 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 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, Czech Republic, Latvia, Netherlands, Ukraine, Great Britain, Lithuania are the main trade partners for Poland. In 2004 exports of the ceramics wall elements amounted to 86 thousand tons worth PLN 24,166 thousand and imports 160 thousand tons worth PLN 39,213 thousand. An export of the roof products amounted to 48 thousand tons worth PLN 42,548 thousand and imports to 137 thousand tons worth PLN 85,506 thousand (Table 6.3).

The negative exports-imports balance has decreased from 2000 and in 2004 it amounted to PLN 58,005 thousand with ceramics wall elements PLN 15,047 thousand (26 %) and roof products PLN 42,958 thousand (74 %).

The exports of the ceramics wall elements has increased five times and imports decreased two times in the last five years. Export and import of the roof products have not changed significantly.

Table 6.3. Directions of Polish imports and exports of building ceramics

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Structural wall- and floor tiles, bricks							
	Total	160.00	39,213		**Total**	85.95	24,166
1	Germany	121.73	24,966	1	Czech Rep.	28.37	5,781
2	Latvia	28.69	8,732	2	Germany	20.10	7,545
3	Belgium	6.58	3,421	3	Slovakia	14.44	1,592
4	Netherlands	2.53	1,705	4	Lithuania	7.96	3,904
5	France	0.18	245	5	Russia	6.66	2,155
6	Ecuador	0.14	62	6	Ukraine	4.01	1,458
7	Czech Rep.	0.07	12	7	Estonia	1.84	806
8	Sweden	0.02	3	8	Latvia	1.13	223
9	Ukraine	0.02	8	9	Belarus	0.45	191
10	Lithuania	0.02	9	10	Netherlands	0.39	227
Roofing tiles and other roofing elements							
	Total	137.35	85,506		**Total**	47.60	42,548
1	Germany	92.20	59,759	1	Germany	36.91	26,973
2	Czech Rep.	22.40	17,571	2	United Kingdom	4.07	6,270
3	Netherlands	18.52	5,135	3	Ukraine	2.90	5,614
4	Estonia	2.45	1,304	4	Denmark	0.89	638
5	France	0.99	1,136	5	Lithuania	0.66	614
6	Latvia	0.63	308	6	Russia	0.48	521
7	Belgium	0.12	145	7	Canada	0.44	697
8	Italy	0.01	18	8	Czech Rep.	0.32	235
9	Spain	0.01	6	9	Estonia	0.26	185
10	Malaysia	0.01	14	10	Norway	0.16	260

7. CERAMIC CLAYS

Two types of ceramic clays are distinguished according to the technology, i.e. the 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 as binding agent of the slightly compact sandstones. The clays output has been declining for the last couple of years. Since 2003 the whiteware clays have not been exploited. There was a new deposit documented in the Lower Silesia in 2004.

The raw material resources amount to 58.59 million tons.

The whiteware ceramic clay resources (for faience and semi-vitreous China-ware) and 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**	**58.59**	**2.68**	**55.91**	**0.05**	–
including reserves of exploited deposits						
Total	0	–	–	–	–	–
including resources of not exploited deposits						
Total	4	58.04	2.15	55.89	–	–
Exploration	2	2.15	2.15	–	–	–
Prospecting	2	55.89	–	55.89	–	–
including abandoned deposits						
Total	2	0.55	0.53	0.02	0.05	–

The **stoneware clays** deposits occur in the Sudetes where they accompany whiteware clays in Cretaceous sediments in the North-Sudetic basin and in Paleogene 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 81.93 million tons, of which 12.71 % occurs in six deposits being exploited. The ceramic clays output amounted to 242 thousand tons of stoneware clays in 2004.

The stoneware clays resources and 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**	**81.93**	**29.09**	**52.84**	**15.92**	**8.87**
including reserves of exploited deposits						
Total	5	10.41	9.99	0.42	5.13	8.87
including resources of not exploited deposits						
Total	11	63.05	12.15	50.90	8.40	–
Exploration	6	15.40	12.15	3.25	2.30	–
Prospecting	5	47.66	–	47.66	6.11	–
including abandoned deposits						
Total	6	8.47	6.95	1.52	2.39	–

8. CHALK

As the chalk we traditionally 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 a calcareous, slightly coherent and porous rock. Chalky limestone similar to chalk occurs in Chełm region in eastern Poland. They are exploited for the production of cement, and are discussed as limestone and marls 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. 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 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.

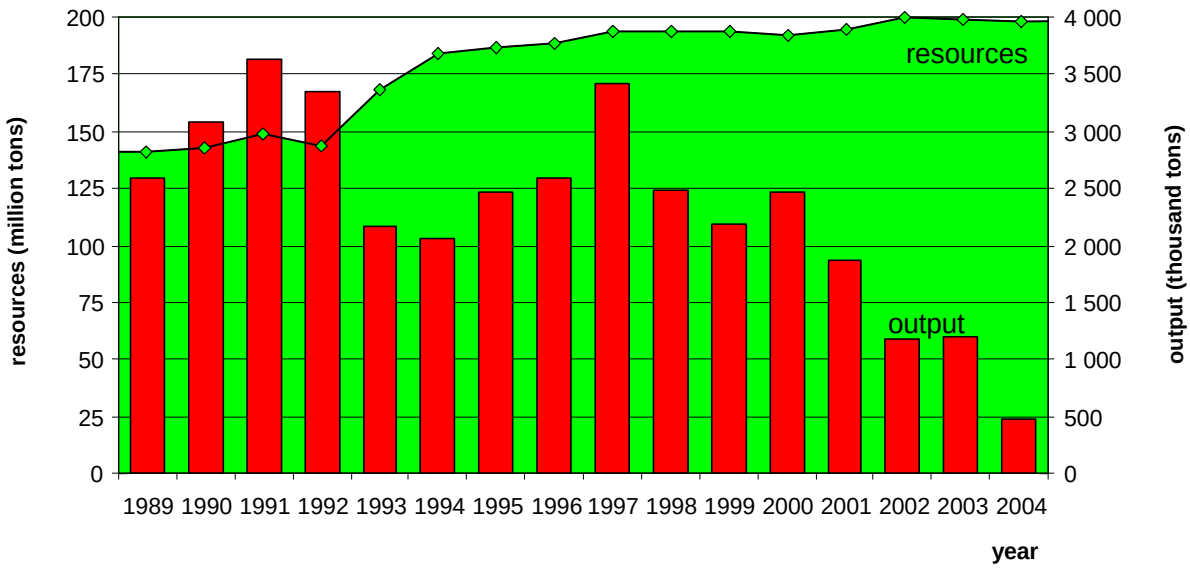
The output amounted in 2004 to 473.55 thousand tons (Fig. 8.1). Output of lacustrine chalk dramatically decreased after the changes of rules of subsidizing to exploitation of calcareous fertilizers, and after last year conjunction of Poland to the European Union. The chalk imports amounted in 2004 to 32.4 thousand tons.

The magnitude of 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.

Table 8.1 Chalk (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**197**	**198.38**	**102.74**	**95.64**	**12.63**	**16.58**
including reserves of exploited deposits						
Total	58	27.16	26.44	0.72	1.86	15.14
including resources of not exploited deposits						
Total	86	128.76	54.28	74.48	0.12	–
Exploration	54	69.74	53.05	16.69	–	–
Prospecting	32	59.02	1.22	57.80	0.12	–
including abandoned deposits						
Total	53	42.46	22.02	20.44	10.65	1.44

Fig. 8.1 Chalk resources and output in Poland in 1989-2004



9. CLAY RAW MATERIALS FOR CEMENT PRODUCTION

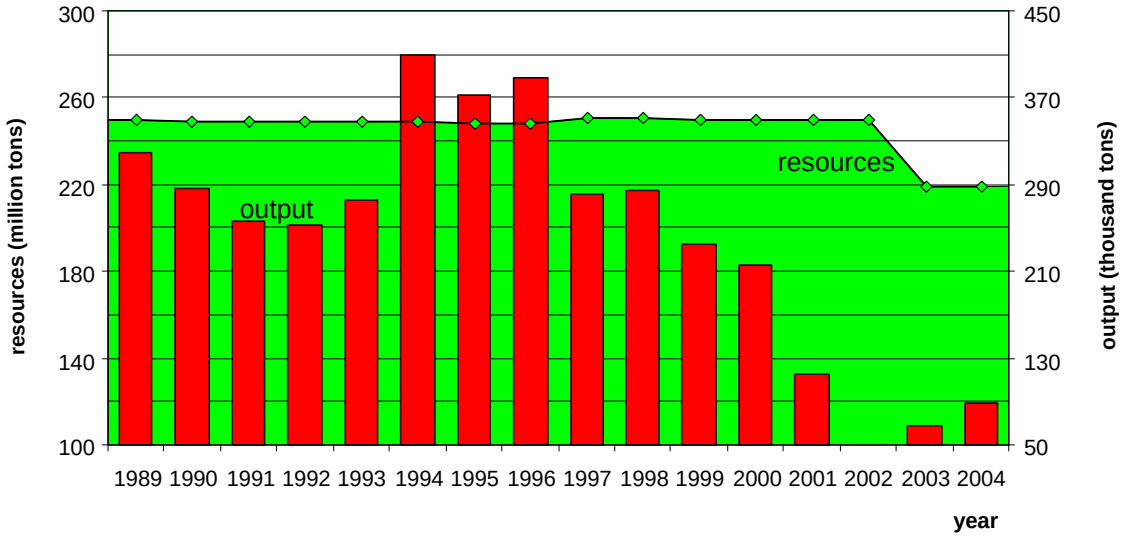
Clay raw materials used for correction of the cement kiln charge occur commonly in the whole country. Their resources have been explored mainly in southern and southeastern Poland, where the cement industry is located. The state of their identification and management is shown in Table 9.1.

The output amounted in 2004 to 89.47 thousand tons (Fig. 9.1).

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	**27**	**219.38**	**181.17**	**38.21**	**45.67**	**2.01**
including reserves of exploited deposits						
Total	5	0.48	0.40	0.08	–	0.09
including resources of not exploited deposits						
Total	15	136.24	98.11	38.13	2.25	1.93
Exploration	14	103.32	98.11	5.21	2.25	1.93
Prospecting	1	32.92	–	32.92	–	–
including abandoned deposits						
Total	7	82.67	82.67	–	43.42	–

Fig. 9.1 Resources and output of clay raw materials for cement production in Poland in 1989-2004



10. CLAY RAW MATERIALS FOR LIGHTWEIGHT AGGREGATE PRODUCTION

Two types of lightweight aggregate are produced in Poland: keramsite and agloporite. For keramsite (lightweight 'bloated' clay aggregate) clays of swell coefficient greater then 2.5 are used, for agloporite swell coefficient of clay is less then 1.0.

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

The resources of clay raw material for lightweight aggregate production amount to 192.67 million m^3, that is equivalent to 385 million tons.

The output of the considered raw materials from two deposits amounted in 2004 to 150.8 thousand m^3 (302 thousand tons).

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

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**48**	**192.67**	**47.18**	**145.49**	**4.60**	**6.70**
including reserves of exploited deposits						
Total	2	17.45	17.45	–	1.28	4.78
including resources of not exploited deposits						
Total	43	169.44	23.95	145.49	3.32	–
Exploration	10	28.98	23.95	5.03	0.06	–
Prospecting	33	140.46	–	140.46	3.26	–
including abandoned deposits						
Total	3	5.79	5.79	–	–	1.92

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 minium, browns and earth green. In Poland so far two deposits of ochre, argils and ochre claystones have been explored in central Poland near the Kielce (Plate 4). In these deposits, in argilic measures of Rhaetic-Liassic, ochre makes lens accumulations. The intrinsically economic resources amount to 578 thousand tons.

The imports of mineral pigments (mainly from China) amounted in 2004 to 220 tons.

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 44 deposits in the Upper Silesian Coal Basin (USCB).

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 (LSCB) and Lublin Coal Basin (LCB) ones no fields of CBM reserves have been proved (Plate 1).

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 266 million m^3 in 2004. The quantity of methane, called emission from ventilation system, emitted in 2004 to the atmosphere from the above-mentioned coal deposits amounted to 149 million m^3 and decreased by 45 million m^3 comparing to 1999. 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				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**44**	**84,944.05**	**5,887.69**	**79,056.36**	**24,627.29**	**3,085.87**
including: Resources in the hard coal exploitation regions	28*	24,978.88	5,031.40	19,947.48	3,832.06	1,916.32
Resources outside the hard coal exploitation regions	19*	59,965.17	856.29	59,108.88	20,795.23	1,169.55

* in the Budryk and Szczygłowice deposits the raw material occurs within and outside the area of actual coal exploitation and in the Lędziny deposit the raw material occurs in the zone accessible for coal mining (maximum depth of 1,000 meters) and in the zone of the depth between 1,000-1,600 meters as the main mineral raw material

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 resources amounted to 2,030 million tons of ore in 2004 with a content of copper of 39.9 million tons (Table 13.1).

Over 66.8 % of the total resources (1,356 million tons) occur in deposits in exploitation.

The resources occur mainly at a depth from 1,000 meters to 1,250 meters even to 1,450 meters.

The economic reserves of the exploited deposits amount to 738 million tons of ore and 17.0 million tons of copper.

The output (Fig. 13.1) of copper ores amounted to 26 million tons of the ore, of which metallic copper amounted to 626 thousand tons in 2004.

Table 13.1 Copper ores (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**15**	* **2,030.67** ** ***39.86***	**1,961.02** ***38.98***	**69.65** ***0.88***	**887.11** ***14.19***	**738.34** ***16.97***
including reserves of exploited deposits						
Total	5	1,356.29 *26.25*	1,356.29 *26.25*	– –	38.70 *0.47*	738.34 *16.97*
including resources of not exploited deposits						
Total	7	603.70 *12.83*	568.74 *12.31*	34.96 *0.52*	810.60 13.45	– –
Exploration	4	436.48 *9.65*	436.48 *9.65*	– –	9.05 *0.08*	– –
Prospecting	3	167.22 *3.18*	132.26 *2.66*	34.96 *0.52*	801.55 *13.37*	– –
including abandoned deposits						
Total	3	70.68 *0.79*	35.99 *0.43*	34.69 *0.36*	37.81 *0.27*	– –

* ore, ** *metallic copper*

Fig. 13.1 Copper ores resources and output in Poland in 1989-2004

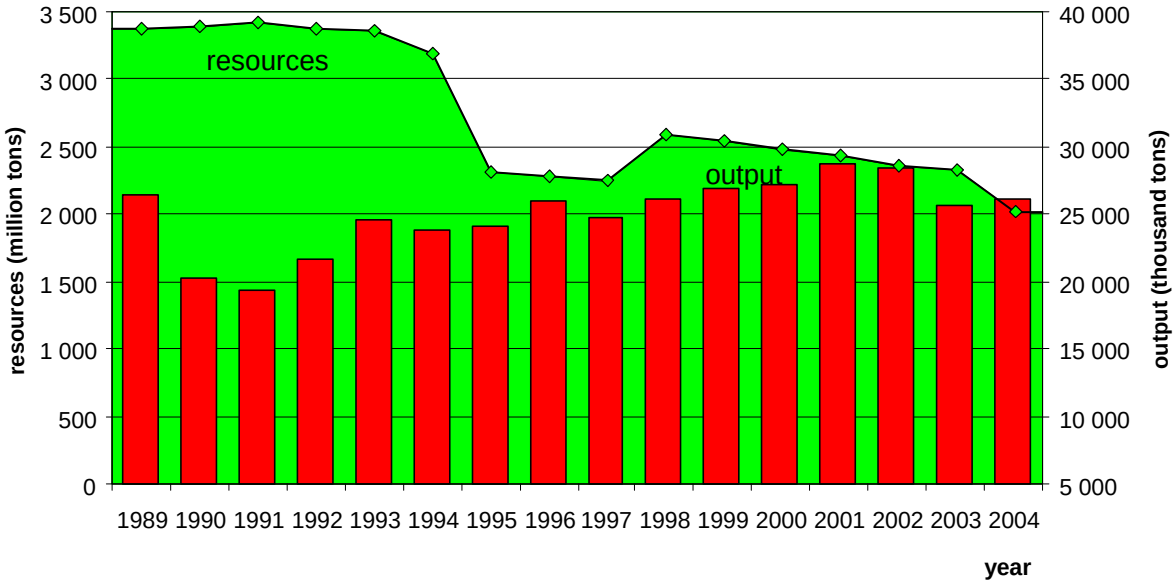
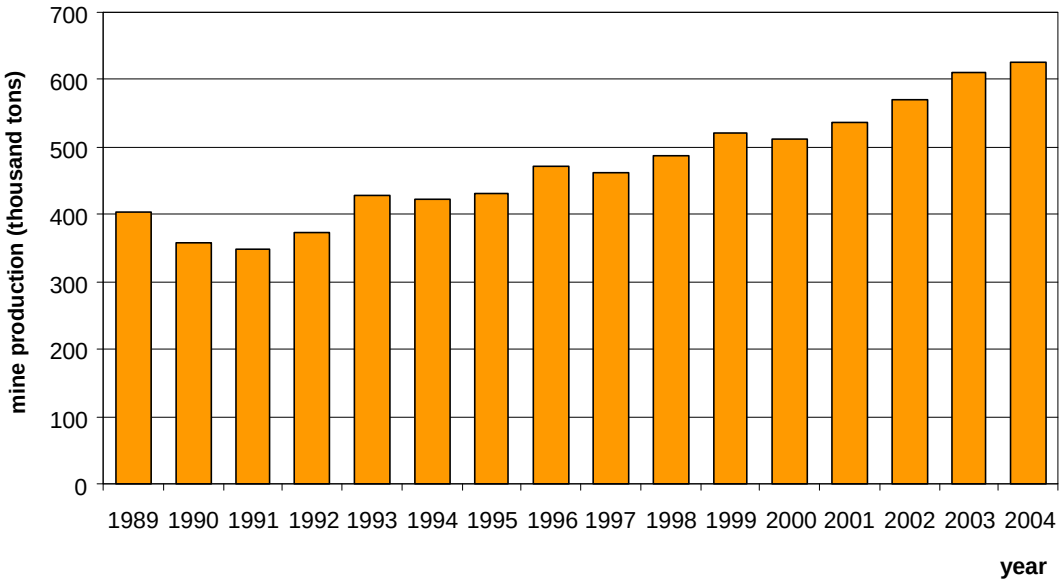


Fig. 13.2 Copper mine production in Poland in 1989-2004



A considerable part of copper production from the domestic deposits is destined to exports (Table 13.2). In 2004, exports of copper amounted to 328.15 thousand tons, mainly electrolytic - cathode, wirebars, and lingots also alloys and copper compounds.

Table 13.2 Directions of Polish imports and exports of copper

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**20.24**	**181,023**		**Total**	**328.15**	**3,215,053**
1	Germany	8.00	76,531	1	Germany	140.17	1,345,242
2	Czech Rep.	4.24	37,870	2	France	68.38	721,192
3	Slovakia	2.16	18,007	3	China	48.63	475,993
4	Russia	1.37	8,834	4	Italy	24.12	244,240
5	Netherlands	0.63	6,193	5	Austria	16.19	161,205
6	Sweden	0.64	6,185	6	Hungary	6.96	73,231
7	Hungary	0.39	3,664	7	Czech Rep.	5.45	43,299
8	Belgium	0.28	3,502	8	Ukraine	3.64	39,361
9	Austria	0.35	2,993	9	Slovakia	4.41	30,696
10	USA	0.14	2,236	10	Netherlands	2.94	28,283
11	France	0.11	1,962	11	Taiwan	1.05	10,051
12	Italy	0.17	1,864	12	United Kingdom	1.31	7,885
13	Belarus	0.29	1,799	13	Belgium	1.34	6,649
14	Bosnia & Herzegovina	0.19	1,679	14	Serbia & Montenegro	0.60	6,583
15	Lithuania	0.17	1,445	15	Sweden	0.78	5,167
16	Morocco	0.13	1,141	16	Romania	0.30	3,406
17	United Kingdom	0.06	1,063	17	Singapore	0.41	3,292
18	Uzbekistan	0.43	1,039	18	India	0.39	2,308
19	Ukraine	0.30	759	19	Latvia	0.22	1,593
20	Latvia	0.07	506	20	Switzerland	0.12	1,301
21	Bulgaria	0.04	397	21	Belarus	0.10	839
22	Spain	0.04	349	22	South Korea	0.09	599

Extracted from copper ores are following elements: Ag, Au, Ni, Pb, Pt–Pd, Se, Zn. Silver extraction is the most important in Polish economy. Over 91.6 % is exported. The production of extracted metals in 2004 amounted to:

- metallic silver: 1,344.2 tons;
- crude lead: 21,015 tons;
- metallic selenium: 82.56 tons;
- nickel (nickel sulfate): 2,161 tons;
- metallic gold: 0.527 tons; and
- slime Pt-Pd: 0.07 tons.

14. CRUDE OIL

In Poland, oil fields occur in the Polish Lowland, on the Baltic Sea, in the Carpathian Foredeep and in the Carpathians (Plate 1).

The Polish Lowland has become the most important petroliferous area in this country since BMB oil field was explored in 1996, the resources of which are more than two times as much as the all Poland resources at the time. In this area the next oil and gas fields (Lubiatów, Kosarzyn) were explored in the last years.

The Polish Lowland accounts for 76.4 % of the national resources, the Baltic Sea 18.6 %, while the Carpathian Foredeep – 1.6 % and the Carpathians 1.5 % 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 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.

On the Baltic area (off shore) crude oil occurs within the Middle Cambrian measures. Hydrocarbon content amounts to 73 % and density to 0.811 g/dm^3. The only exploited deposit is B3, the B8 is explored in the details.

In the Carpathian Foredeep, oil fields occur in the Paleogene sediments and the Mesozoic sediments of a platform type (mainly Jurassic carbonate rocks, rarely in Cretaceous sandstones) that 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/cm^3. 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.

Among 89 oil fields 69 are under exploitation and their resources amount to 93.5 % of the total Polish reserves.

The intrinsically economic oil resources of Poland amounted to about 19,519 thousands tons in 2004, with the total economic reserves amounting to 16,218 thousand tons.

The production (Fig. 14.1) of oil and condensate amounted to 866 thousand tons in 2004. The production of oil from the Carpathian oil fields amounted to 3.44 % of the total Polish oil production, from the Carpathian Foredeep to 2.50 %, from the Polish Lowland to 64.75 % and from the Polish economic zone of the Baltic Sea to 29.33 %.

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	*** 89**	**19,519**	**6,831**	**12,688**	**424**	**16,218**
	**** 77**	**17,202**	**6,807**	**10,394**	**424**	**16,152**
	***** 6**	**1,479**	**24**	**1,455**	–	**66**
including reserves of exploited fields						
Total	69	18,259	6,723	11,536	94	16,218
	66	16,842	6,718	10,124	94	16,152
	3	1,328	5	1,324	–	66
the Carpathians	32	287	169	118	42	151
	32	286	169	116	42	151
	1	2	–	2	–	–
the Carpathian Foredeep	7	187	187	–	45	127
	6	182	182	–	45	127
	1	5	5	–	–	–
Polish Lowland	29	14,906	4,937	9,969	8	13,061
	27	13,495	4,937	8,558	8	12,994
	1	1,322	–	1,322	–	66
Baltic (off shore)	1	2,879	1,429	1,449	–	2,878
	1	2,879	1,429	1,449	–	2,878
including resources of not exploited fields						
Total	12	1,110	108	1,002	330	–
	6	210	89	121	330	–
	3	150	19	131	–	–

Specification	Number of fields	Extractable Reserves / resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
the Carpathian Foredeep	4 4	121 121	– –	121 121	330 330	– –
Polish Lowland	5 2 3	239 89 150	108 89 19	131 – 131	– – –	– – –
Baltic (off shore)	3 –	750 –	– –	750 –	– –	– –
including abandoned fields						
Total	8 5	150 150	- -	150 150	– –	– –
the Carpathians	2 2	– –	– –	– –	– –	– –
Polish Lowland	6 3	150 150	– –	150 150	– –	– –

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

Fig. 14.1 Crude oil resources and output in Poland in 1989-2004

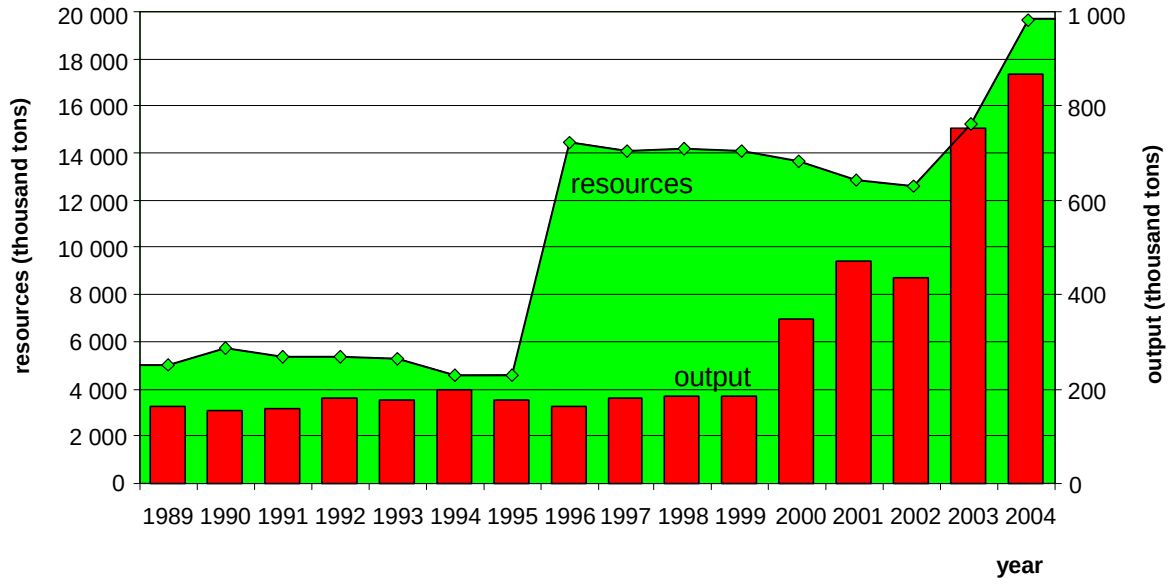


Table 14.2 Directions of Polish import of crude oil

No	Country	Thousand tons	Thousand PLN
	Total	**17,316.13**	**15,496,038**
1	Russia	16,669.79	14,798,371
2	Ukraine	327.74	340,294
3	Kazakhstan	185.07	190,899
4	Norway	132.02	164,873
5	Czech Rep.	1.50	1,558

Imports of oil amounted to 17,316 thousand tons in 2004. Directions and quantities of imports are shown in Table 14.2. Over 96 % of oil imported to Poland came from Russia, 1.89 % from Ukraine and 1.07 % from Kazakhstan. Imports of oil products (fuels, paraffin, oils, mineral jelly, waxes, etc.) amounted to 5,641 thousand tons while exports to 2,331 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 bitumen

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Oil products							
	Total	**5,640.61**	**7,914,699**		**Total**	**2,331.55**	**2,662,711**
1	Belarus	1,042.33	1,393,797	1	Czech Rep.	627.68	809,655
2	Russia	1,035.66	1,329,057	2	Sweden	230.31	321,826
3	Germany	625.91	994,767	3	Denmark	319.26	261,050
4	Lithuania	688.04	969,778	4	Netherlands	200.60	253,402
5	Slovakia	404.93	592,751	5	Slovakia	128.09	175,349
6	Sweden	386.51	478,197	6	Norway	232.06	148,462
7	Latvia	213.04	374,512	7	Stock	175.99	134,003
8	Ukraine	268.28	348,158	8	Hungary	71.78	98,478
9	Kazakhstan	257.01	341,835	9	United Kingdom	71.09	94,181
10	Czech Rep.	172.29	230,234	10	Germany	97.08	91,928
11	Hungary	111.64	165,421	11	Belgium	44.91	61,736
12	United Kingdom	99.43	160,503	12	Austria	23.41	36,556
13	France	39.26	95,210	13	Ukraine	5.01	20,656
14	Denmark	57.12	80,682	14	Slovenia	6.78	11,256
15	Belgium	22.36	61,857	15	Estonia	5.87	9,458
16	Austria	23.59	53,607	16	Russia	3.48	8,970
17	Norway	35.09	51,388	17	Nigeria	5.47	8,732
18	Italy	25.14	45,340	18	Latvia	5.36	8,700
19	Netherlands	13.91	36,428	19	France	4.63	7,632
20	Finland	14.91	25,996	20	Egypt	3.74	7,377
21	USA	70.81	23,270	21	Cyprus	7.98	7,293
22	China	6.62	17,450	22	Croatia	2.96	7,192
23	Spain	10.00	17,238	23	Cuba	3.89	6,479
24	Croatia	6.10	8,225	24	Malta	7.91	6,288
25	Switzerland	3.64	6,867	25	Turkey	2.72	5,862
26	Canada	0.42	1,942	26	Lithuania	4.76	5,557
27	Nauru	1.57	1,805	27	Italy	3.14	5,486
28	Japan	0.10	1,706	28	Belarus	1.42	5,422
29	South Africa	0.67	1,342	29	Tunisia	2.62	5,355
30	Portugal	1.85	1,163	30	USA	1.75	4,462
31	Turks & Caicos	0.53	1,030	31	Romania	1.54	3,727
32	Neth. Antilles	0.22	856	32	Finland	3.75	3,720
33	Unidentified country	0.67	780	33	Switzerland	1.65	3,301
34	Turkey	0.24	596	34	Sweden	1.19	2,108
35	Romania	0.30	325	35	United Arab Emirates	0.75	1,939
36	Vatican	0.16	215	36	Israel	0.93	1,911
37	Egypt	0.23	178	37	Ireland	0.94	1,653
38	Ireland	0.01	73	38	Bulgaria	0.60	1,550
39	Ecuador	0.01	35	39	Serbia & Montenegro	1.10	1,458
40	South Korea.	0.00	22	40	Bahamian	1.25	1,208
41	Slovenia	0.00	14	41	Greece	1.43	1,140

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
42	Israel	0.00	13	42	Panama	1.57	1,113
43	Bosnia & Herzegovina	0.00	10	43	Hong Kong	1.99	1,104
44	Taiwan	0.00	8	44	Bosnia & Herzegovina	0.42	1,006
45	Hong Kong	0.00	7	45	Kuwait	0.40	895
46	Malaysia	0.00	5	46	Saudi Arabia	0.76	666
47	Australia	0.00	4	47	Portugal	0.31	570
Natural bitumen							
	Total	**15.35**	**26,119**		**Total**	**27.87**	**24,268**
1	Germany	4.97	11,160	1	Czech Rep.	19.38	16,033
2	Czech Rep.	8.22	7,952	2	Russia	3.25	2,872
3	Netherlands	0.38	2,107	3	Germany	3.08	2,062
4	USA	0.34	1,144	4	Ukraine	0.39	1,031
5	France	0.29	1,105	5	Hungary	0.84	778

15. DIATOMACEOUS ROCK

Diatomite is a silica-argillaceous, lightweight, porous rock of strong sorption 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 of 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 magnitude of resources and reserves of diatomaceous rock and state of their identification and management are presented in Table 15.1.

The explored intrinsically economic resources amount to 10.03 million tons. In last years two mining plants were operating in the Leszczawka region. In 2004 exploitation was provided from mining plant Jawornik with output only 790 tons.

The actually used enrichment technology does not allow extracting from diatomaceous rock products of good quality, 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.

Table 15.1 Diatomites (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**4**	**10.02**	**3.28**	**6.74**	**2.74**	**0.21**
including reserves of exploited deposits						
Total	1	0.65	0.45	0.20	–	0.21
including abandoned deposits						
Total	3	9.38	2.84	6.54	2.74	–

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 Krosno measures in South-Eastern Poland in the Błażowa and Godów regions 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 8,2 billion tons explored in 556 deposits (Table 16.1). Limestone from the deposits recognized for the cement and lime industry as well as dolomite for the metallurgical and agriculture industries are not included here.

The variation of the reserves in the past twenty-five years indicated an intensive increase of resources owing to the identification of new deposits before 1981 when an increase of the 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	**556**	**8,201.85**	**5,189.08**	**3,012.77**	**514.25**	**2,869.92**
including reserves of exploited deposits						
Total	227	3,874.90	3,089.77	785.13	111.10	2,801.77
including resources of not exploited deposits						
Total	180	3,697.17	1,533.42	2,163.75	382.18	68.15
Exploration	134	1,793.99	1,533.42	260.57	125.03	68.15
Prospecting	46	1,903.19	–	1,903.19	257.15	–
including abandoned deposits						
Total	149	629.79	565.9	63.89	20.96	–

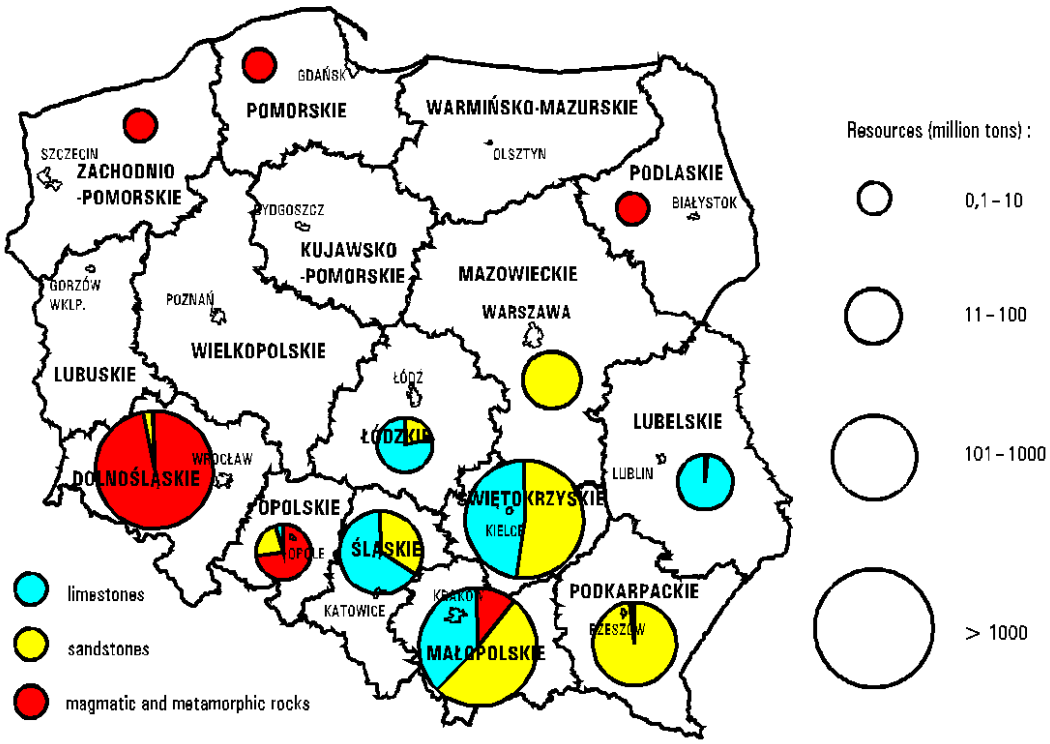
The exploitation of dimension and crushed stones is conducted in 227 deposits the reserves of which are almost 3.9 billion tons (above 47 % of the total resources). In the resource balance of Poland additional 180 deposits suitable for management are noted the total resources of which account to 3.7 billion tons. In 149 deposits the extraction was abandoned even though they still contain almost 0.6 billion tons of resources.

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

Raw material	Intrinsically economic resources	Output	Number of deposits
T o t a l	**8,201.85**	**28.70**	*** 556**
Magmatic rocks - total	**3,645.97**	**14.81**	**160**
Basalts	601.76	6.12	47
Gabbros and diabases	455.45	1.62	5
Granitoids	1,468.81	2.51	73
Melaphyres	1,061.23	4.18	27
Syenites	40.47	0.38	7
Porphyric tuffs	18.27	-	1
Metamorphic rocks - total	**684.69**	**1.02**	**46**
Amphibolites	62.31	0.42	6
Gneisses and hornfelses	159.80	0.05	16
Marbles	439.08	0.37	22
Serpentinites	23.51	0.18	2
Sedimentary rocks - total	**3,871.19**	**12.88**	**360**
Dolomites	712.56	4.94	33
Sandstones and conglomerates	1,491.56	2.74	208
Siliceous rocks	31.83	0.16	4
Limestones and marls	1,634.79	5.04	113
Menilite schists	0.45	-	2

* a total of 10 deposits contain two raw materials for manufacturing both dimension and crushed stones

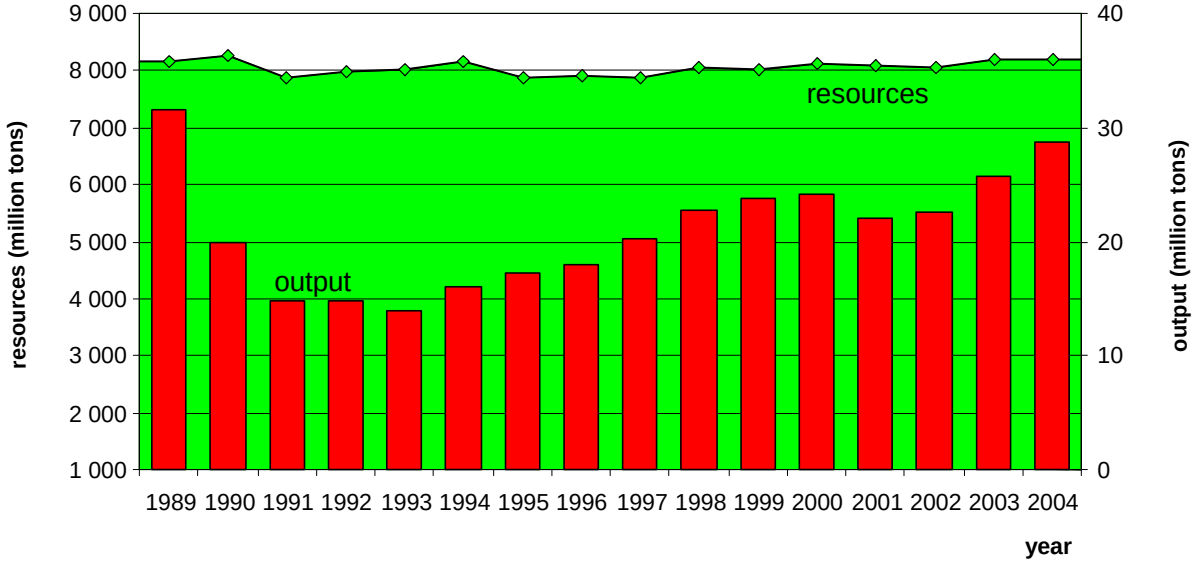
Fig. 16.1 The distribution of resources and principal lithologic types of dimension and crushed stones in Poland in 2004



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 occurs in the Lower Silesia (nearly 53.1 % of resources), corresponding mainly to the magmatic and metamorphic rocks. The sedimentary rocks appear there only in small quantities. The remaining resources of the sedimentary rocks occur in the following regions: the Holy Cross Mountains (24.3 %) – mainly limestones and sandstones, the Carpathians 13.4 %) – sandstones, and the Silesia-Cracow Upland (9.0 %) – limestones. Small limestone deposits occur in the Lublin region being the base for the aggregate production and the raw material in the cement industry. In northern Poland – single deposits of erratics are encountered.

The output of dimension and crushed stone has continuously increased in the past decade. The maximum output in this period was noted in 2004 (Fig. 16.2). These magnitudes show the management potential of this group of raw materials. The present level of exploitation exceeds 28.7 million tons.

Fig. 16.2 Dimension and crushed stones resources and output in Poland in 1989-2004



Some lithologic types of the 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 the block stones are extracted wherever it is possible. Mine wastes obtained after the extraction of the blocks are used as crushed aggregates. Among the sedimentary rocks such as limestones and sandstones that are present in the largest number of deposits, only some are suitable for the block extraction.

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

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Pitchers, slabs and curbs							
	Total	**3.79**	**1,789**		**Total**	**166.65**	**43,142**
1	Turkey	0.24	592	1	Germany	164.01	41,989
2	Germany	1.16	450	2	Austria	0.81	446

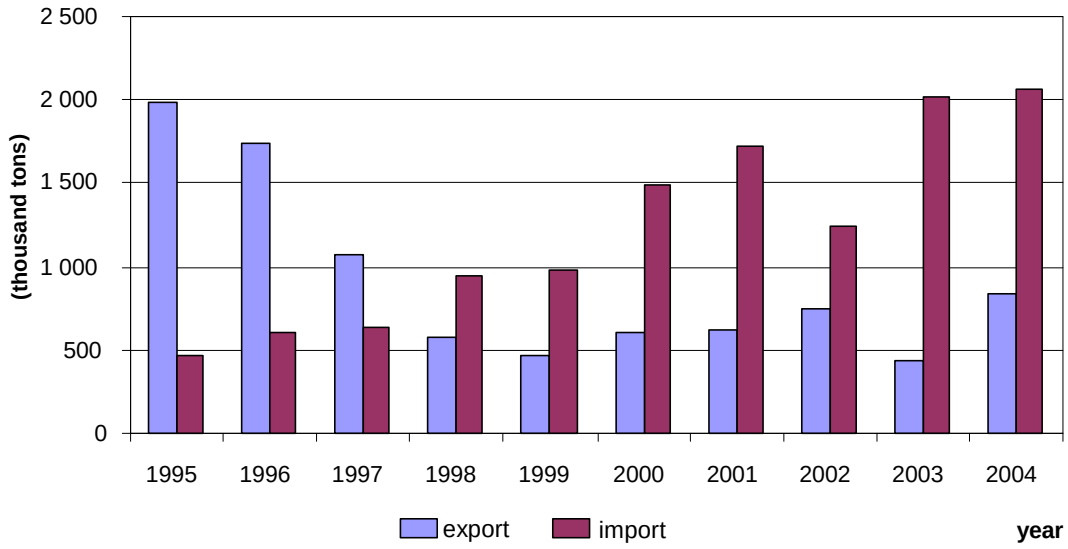
Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Crushed stone							
	Total	**1,586.38**	**101,038**		**Total**	**553.39**	**12,792**
1	Czech Rep.	72.61	19,729	1	Germany	535.02	9,874
2	Ukraine	709.07	13,467	2	Czech Rep.	15.46	1,864
3	Norway	209.88	12,991	3	Russia	1.19	520
4	Sweden	339.55	12,470	4	Latvia	0.24	138
5	Germany	33.43	12,273	5	Ukraine	0.32	137
6	Slovenia	19.11	8,320	6	Lithuania	0.84	98
7	Austria	17.32	6,728	7	Belarus	0.09	44
8	United Kingdom	112.06	4,657	8	Slovakia	0.17	31
9	Italy	8.36	4,506	9	Estonia	0.02	22
10	Finland	22.58	3,953	10	Sweden	0.01	15
11	Slovakia	34.00	756	11	Singapore	0.00	8
Dimension stone							
	Total	**469.71**	**344,578**		**Total**	**123.50**	**73,072**
1	South Africa	111.33	87,110	1	Germany	114.56	56,099
2	Italy	25.87	57,808	2	Denmark	0.34	3,866
3	India	25.13	26,962	3	Austria	0.68	2,425
4	Sweden	80.20	26,923	4	Slovakia	0.94	1,809
5	China	17.91	24,189	5	Italy	1.57	1,432
6	Spain	21.86	22,560	6	France	0.16	1,041
7	Finland	32.49	16,605	7	Russia	0.35	875
8	Belgium	8.50	15,011	8	Belgium	0.02	868
9	Czech Rep.	51.48	14,384	9	Ukraine	0.36	808
10	Brazil	10.00	11,850	10	Belarus	0.25	763
11	Turkey	3.63	6,331	11	Switzerland	2.52	752
12	Germany	8.42	6,330	12	Czech Rep.	1.02	635
13	Ukraine	19.11	5,126	13	USA	0.14	416
14	Portugal	2.53	4,508	14	Netherlands	0.15	330
15	Norway	35.28	4,158	15	Norway	0.07	240
16	Zimbabwe	3.90	3,690	16	Sweden	0.14	151
17	France	4.82	2,372	17	Latvia	0.04	126
18	Greece	0.76	1,793	18	United Kingdom	0.01	112
19	Egypt	1.24	1,381	19	Lithuania	0.05	80
20	Croatia	0.90	1,341	20	Hungary	0.05	62

Crushed aggregates generally represent a 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 a good example of such raw materials.

During last 10 years, imports of the dimension and crushed stones have been increasing continuously. In 2004 they exceeded 2 million tons. The main directions for the imports are from Scandinavian countries and from Ukraine.

In 1995 exports have reached 2 million tons and decreasing further to 446 thousand tons in 1999. In 2004 exports amounted to 844 thousand tons. Germany was the main contractor.

Fig. 16. 3 Polish exports and imports of dimension and crushed stones in 1995-2004



17. DOLOMITES

Dolomites are used in the metallurgical industry as fluxes, in the agriculture industry as magnesium-calcium mineral fertilizers, 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 Silesian voivodeship (Plate 6). They are bedded Triassic (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 shale. 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 dolomite from the Ołdrzychowice-Romanowo deposit is used for production of grits. The dolomites resources from this deposit are classified as road and building stones (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 deposits resources and the state of their identification and management are presented in Table 17.1.

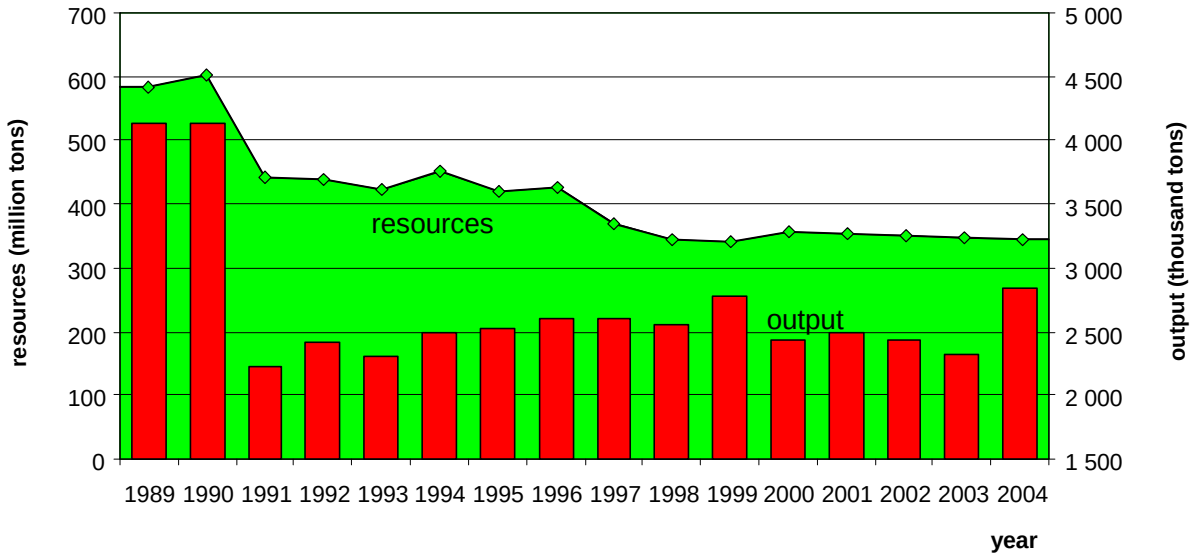
The resources amount to 347 million tons. Over 45.5 % of these resources occur in four deposits being exploited. Four explored deposits remain to be managed, as well as numerous prospective areas, mainly in the Silesian-Cracow region and several in the Holy Cross Mountains. The output of dolomite for the metallurgical and agricultural industries amounted to 2,846 thousand tons in 2004 (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 covered by imports. Imports amounted to 121.3 thousand tons while exports only to 13.6 thousand tons in 2004.

Table 17.1 Dolomites (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**11**	**346.85**	**219.27**	**127.58**	**10.57**	**133.43**
including reserves of exploited deposits						
Total	4	157.80	118.72	39.08	10.02	133.43
including resources of not exploited deposits						
Total	5	136.69	72.41	64.28	0.55	–
Exploration	3	86.22	72.41	13.81	0.55	–
Prospecting	2	50.47	–	50.47	–	–
including abandoned deposits						
Total	2	52.36	28.14	24.22	–	–

Fig. 17.1 Dolomite resources and output in Poland in 1989-2004



18. FELDSPAR RAW MATERIALS

The deposits of feldspar raw materials occur in the Lower Silesia 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 amounted to 86.8 million tons in 2004.

Actually, two deposits are in exploitation and their resources amount to 11.3 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 materials have been rising systematically since 1999 and amounted to 255 thousand tons in 2004 due to the bigger and bigger demand for this raw material in Poland (Fig. 18.1).

Imports of feldspar raw material have rose too and amounted to 201.3 thousand tons worth PLN 39,734 thousand in 2004.

Table 18.1 Feldspar raw materials (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**7**	**86.84**	**14.57**	**72.27**	**13.18**	**3.48**
including reserves of exploited deposits						
Total	2	11.28	8.51	2.77	–	3.48
including resources of not exploited deposits						
Total	5	75.57	6.07	69.50	13.18	–
Exploration	2	14.19	6.07	8.12	–	–
Prospecting	3	61.38	–	61.38	13.18	–

Fig. 18.1 Feldspar raw materials resources and output in Poland in 1989-2004

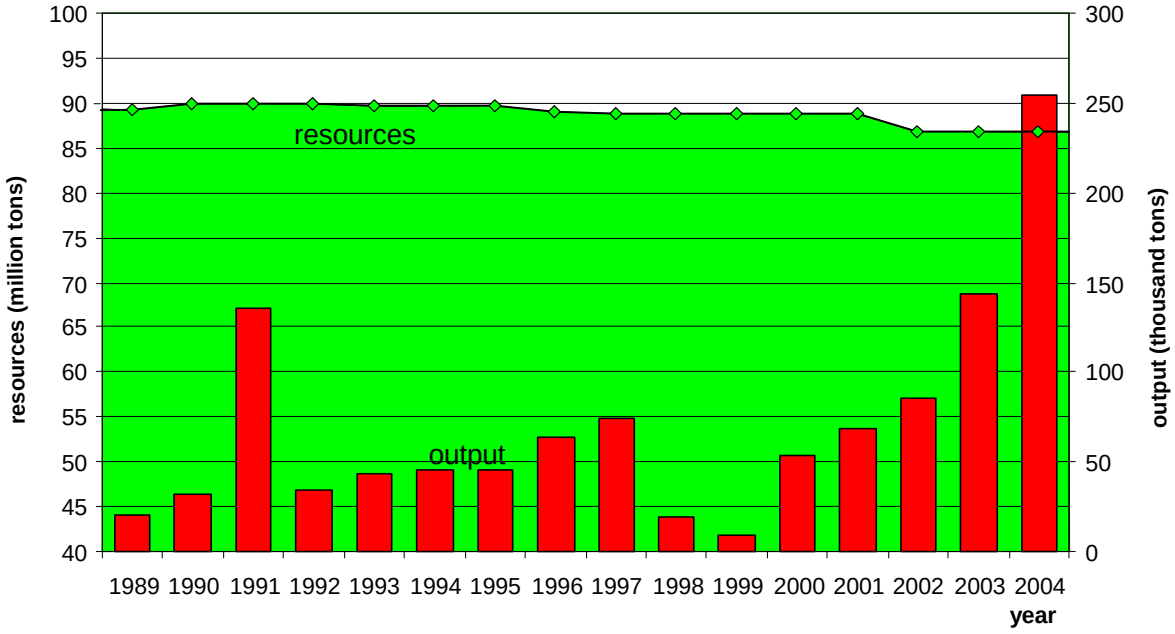


Table 18.2 Directions of Polish import of feldspar raw materials

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**201.34**	**39,734**				
1	Czech Rep.	109.57	14,618	4	Finland	10.27	3,881
2	Turkey	59.92	11,765	5	Spain	3.91	1,242
3	Norway	13.45	6,529	6	Germany	1.15	1,026

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 Kraków-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, several 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 1,400ºC is required, for casting iron 1,350ºC, and for casts from non-ferrous metals 1,200ºC.

Deposits of foundry sands occur mainly in the central and southern parts of Poland (Plate 7). These deposits usually form 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, Paleogene and Quaternary.

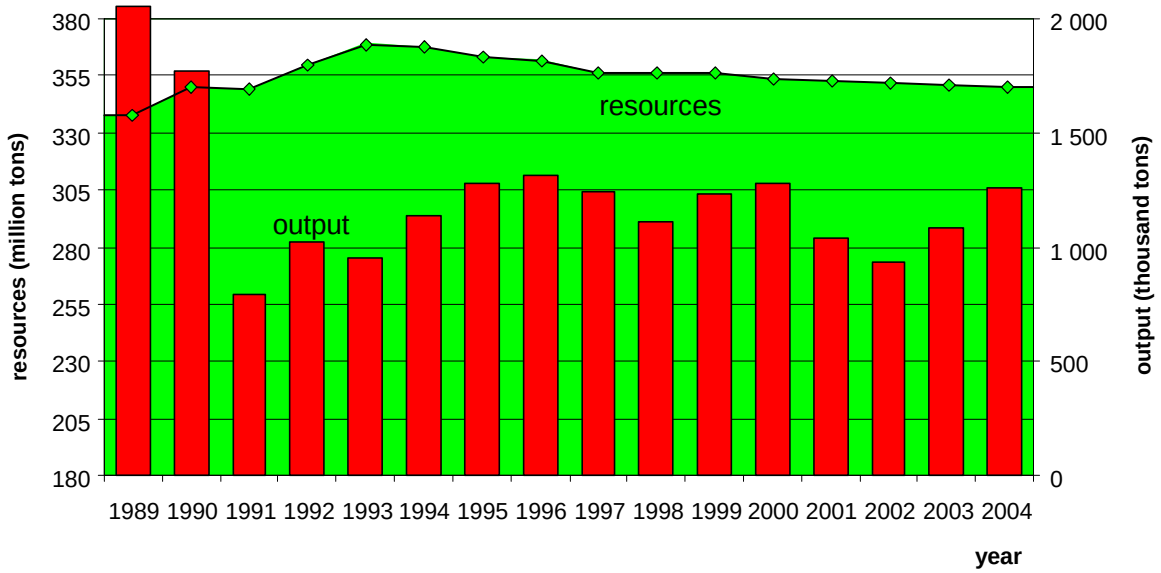
Jurassic foundry sands occur in the western part of the Kraków-Częstochowa Upland (the area between Gorzów Śląski and Żarki - sands and slightly compact sandstones belonging to the Lower and Middle Jurassic rocks) and in the north-west and the north-east of the surrounding of the Holy Cross Mountains (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				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**78**	**349.61**	**198.99**	**150.62**	**5.99**	**67.52**
including reserves of exploited deposits						
Total	12	115.72	115.72	–	3.30	64.95
including resources of not exploited deposits						
Total	39	211.88	65.03	146.85	2.24	2.58
Exploration	18	68.98	65.03	3.95	2.10	2.58
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 1989-2004



Paleogene 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 deposits structure 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 foundry sand resources and state of their identification and management are presented in Table 20.1. The foundry sands resources in all deposits amount to 349.61 million tons and decreased by 6.14 million tons comparing to 1999. The resources of the exploited deposits amount to 33 % of the total resources.

The foundry sands exploitation amounted to 1,258 thousand tons in 2004 and increased by 28 thousand tons comparing to the output in 1999. The changes in foundry sand reserves and their output in the last fifteen years (1989-2004) are shown in Fig 20.1.

In the course of draining the mines, 1,674 thousands m^3 of drinking and industrial waters were pumped off and 38 % 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**	**601.40**	**343.05**	**258.35**	**136.77**	**211.31**
including reserves of exploited deposits						
Total	7	133.91	114.08	19.83	32.24	114.64
including resources of not exploited deposits						
Total	19	465.34	226.81	238.53	104.51	96.67
Exploration	11	268.63	226.81	41.82	66.84	96.67
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 southwestern 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 that 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 that occur here amount to several dozen tons. The company KGHM Polska Miedź S.A. extracted 527 kg of gold from the Lubin-Małomice, Polkowice, Rudna and Sieroszowice copper deposits in 2004.

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).

Imports of gold (mainly in the form of crude gold) amounted to 218 kg in 2004, while exports of gold (mainly scrap) amounted to 4,074 kg of the value of PLN 8,810 thousand.

23. GYPSUM AND ANHYDRITE

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

The Nida valley is one of the richest gypsum-bearing regions in Poland. Gypsum occurs here in the considerable area just under the ground surface or under a little thick overburden (1.5-15 m). The gypsum bed thickness ranges from a minimum of 10 m to a maximum of 46 m. The content of $CaSO_4 \cdot 2H_2O$ 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 natural gypsum and anhydrite output amounted in 2004 to 1 170 thousand tons.

Production of synthetic gypsum as by-product of desulfurisation of exhaust gases in coal-fired power plants increases. It amount to more then 1 million ton per year, and is bigger then production of natural gypsum (except anhydrite). In some assortments they made strong competition for natural gypsum.

Table 23.1 Gypsum and anhydrite (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**15**	**260.88**	**187.01**	**73.87**	**25.96**	**115.43**
including reserves of exploited deposits						
Total	4	115.12	92.03	23.09	6.78	103.50
including resources of not exploited deposits						
Total	8	142.18	91.50	50.68	19.13	11.93
Exploration	6	108.92	91.50	17.42	17.90	11.93
Prospecting	2	33.26	–	33.26	1.23	–
including abandoned deposits						
Total	3	3.58	3.48	0.10	0.05	–

Fig. 23.1 Gypsum and anhydrite resources and output in Poland in 1989-2004

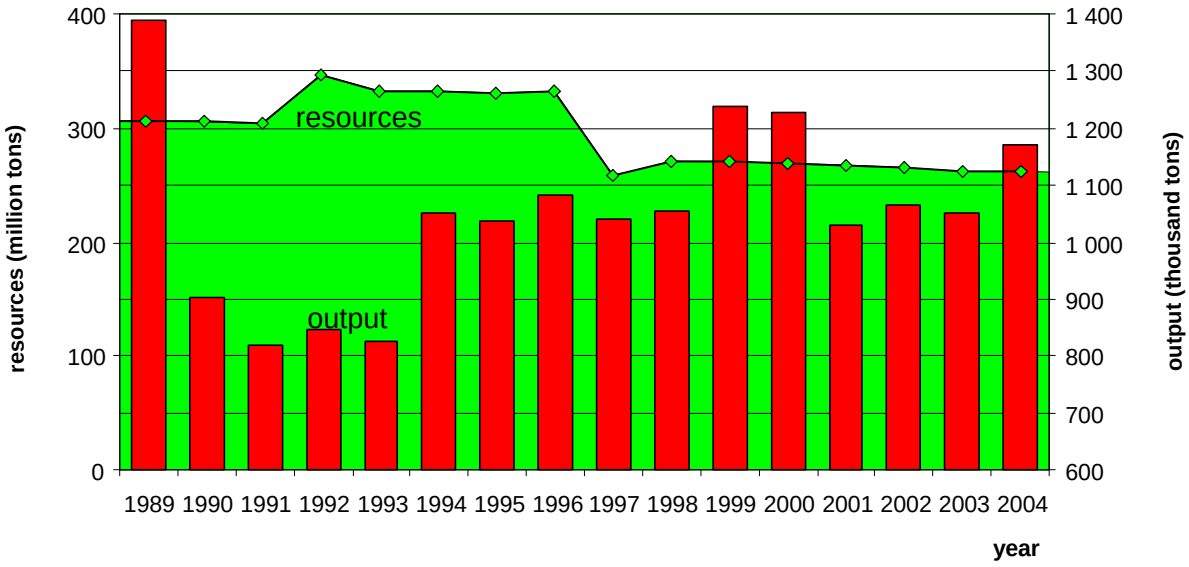


Fig 23.1 presents the resources and output of gypsum and anhydrite in Poland in the period 1989-2004.

The domestic resources of gypsum and anhydrite allow covering the whole Polish demand. Imports mainly of: gypsum plaster, gypsum building products and a little gypsum amounted in 2004 to about 319 thousand tons, and exports of these materials amounted to 637 thousand tons.

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

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

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**319.40**	**83,182**		**Total**	**636.93**	**288,499**
1	Germany	279.33	65,594	1	France	107.40	58,939
2	France	5.00	5,902	2	Romania	110.29	51,176
3	United Kingdom	1.81	2,518	3	Germany	71.87	38,172
4	Sweden	0.15	2,276	4	Ukraine	120.56	32,098
5	Austria	3.25	1,498	5	Russia	55.94	27,539
6	Czech Rep.	1.82	933	6	Lithuania	49.05	20,256
7	Netherlands	0.12	884	7	Belarus	21.28	10,599
8	Denmark	0.47	816	8	Hungary	23.00	10,265
9	Moldova	24.44	555	9	United Kingdom	18.45	10,145
10	Belgium	0.17	360	10	Bulgaria	12.72	5,831
11	Spain	0.21	347	11	Latvia	11.75	5,088
12	Portugal	0.34	315	12	Slovakia	8.36	3,878
13	Lithuania	0.58	270	13	Czech Rep.	6.97	3,207
14	Italy	0.12	223	14	Moldova	5.88	2,676
15	Slovenia	0.02	180	15	Estonia	5.70	2,671

24. HARD COAL

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

The area of the part of the Upper Silesian Coal Basin (Plate 2) located within Polish borders amounts to about 5,800 km^2 (Fig. 24.2). 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 0-1,000 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 Lublin Coal Basin (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 Lower Silesian Coal Basin 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 identified intrinsically economic resources of coal deposits as of 31 December 2004 amounted to 42,580 million tons. The reserves of the exploited deposits constitute actually about 37,6 % of the intrinsically economic resources and amount to 16,040 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 6,928 million tons in 2004.

The net output of coal amounted to 95,623 thousand tons in 2004 from 48 operating underground mines. From this mines 47 are operating in Upper Silesia and one (Bogdanka) in Lublin Coal Basin. After dramatic decrease in the previous years (Fig. 24.1) it reached the level forecasted for the nearest future.

The exploitation of coal was accompanied by the production of 18,453 thousand tons of mining wastes, 12,978 thousand tons of which were used for various purposes (e.g. ground levelling, engineering work, etc.) while 5,475 thousand tons were dumped on coal mine dumps or so called central dumps.

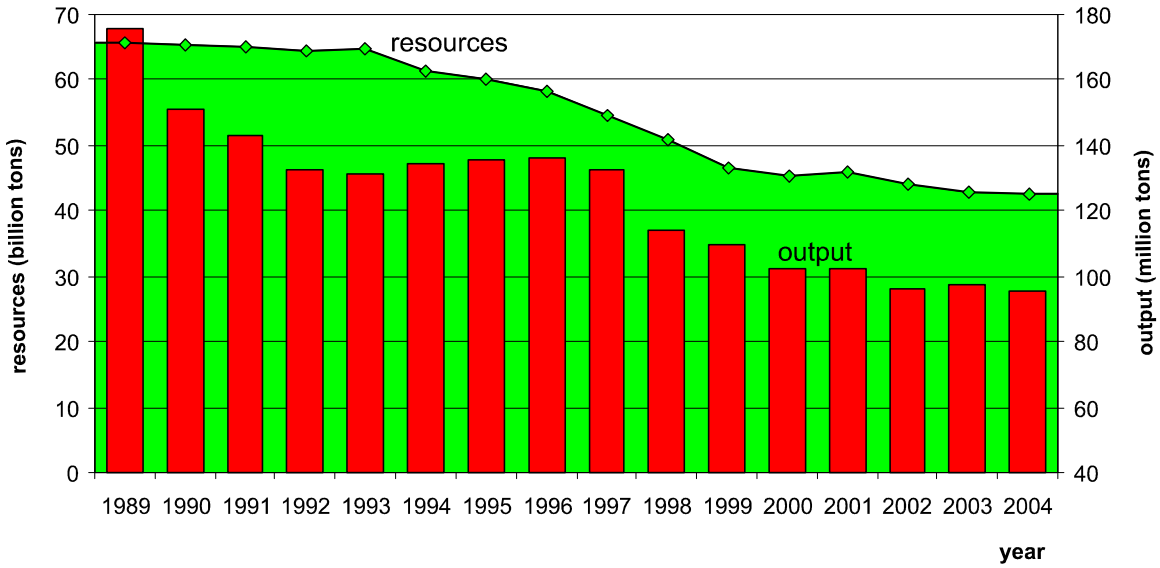
Mine drainage reached 181.5 million m^3 of water in 2004 and 55.4 million m^3 (30.5 %) of the water was utilized, while 126 million m^3 (69.5 %) was drained to the rivers and streams of the Vistula and Odra catchments.

More than 20 % 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 24.1 Hard coal (million tons)

Specification	Number of deposits	Reserves/resources					
		I E R				Potentially economic: marginal economic submarginal	Economic reserves
		Total	Exploration A+B	Exploration C1	Prospecting C2		
Total resources	**133**	**42,580**	**4,455**	**11,596**	**26,529**	**17,214** **10,156**	**6,928**
including reserves of exploited deposits							
Total	48	16,040	4,132	7,002	4,906	5,741 5,060	6,928
including resources of not exploited deposits							
Total	44	26,474	321	4,591	21,562	11,210 1,338	–
Exploration	31	13,550	321	4,351	8,878	4,294 1,231	–
Prospecting	13	12,923	–	239	12,684	6,916 107	–
including abandoned deposits							
Total	41	66	2	3	61	263 3,758	–

Fig. 24.1 Hard coal resources and output in Poland in 1989-2004



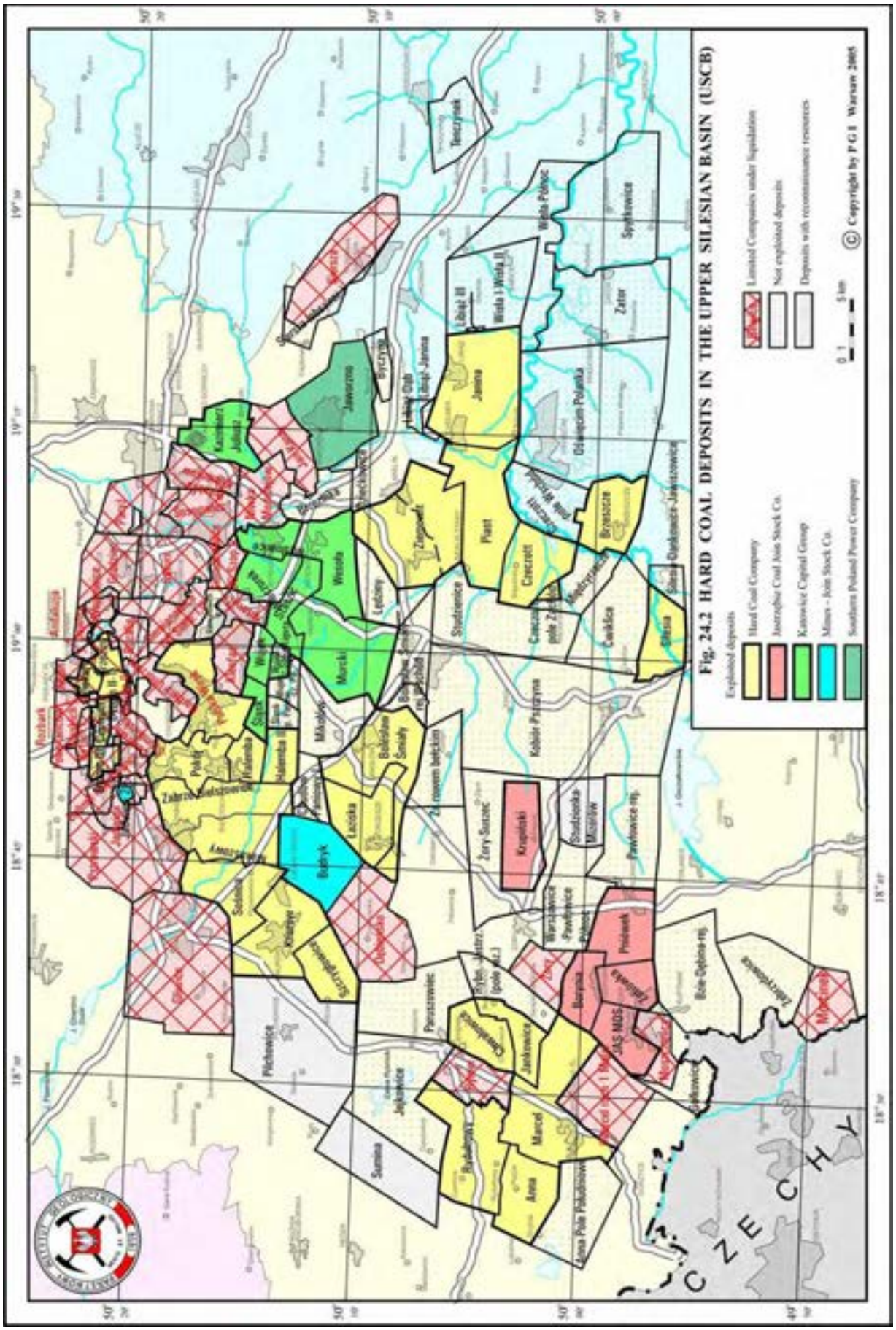


Fig. 24.2 HARD COAL DEPOSITS IN THE UPPER SILESIAN BASIN (USCB)
Explored deposits
Hard Coal Company
Jastrzębie Coal Joint Stock Co.
Katowice Capital Group
Mines - Joint Stock Co.
Southern Poland Power Company
Limited Companies under liquidation
Not explored deposits
Deposits with reconnaissance resources
0 1 5 km
© Copyright by PGI Warsaw 2005
CZECHY

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

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Hard coal							
	Total	**19,697.55**	**5,079,570**				
1	Germany	7,264.32	1,802,025	15	Norway	183.01	54,101
2	Austria	2,145.11	529,642	16	Netherlands	190.56	51,306
3	Slovakia	1,291.91	523,396	17	Italy	96.10	23,723
4	Finland	1,619.15	401,627	18	India	45.67	19,077
5	Czech Rep.	1,245.07	320,894	19	USA	67.68	17,754
6	United Kingdom	1,399.16	304,304	20	Egypt	37.13	14,466
7	France	818.63	245,411	21	Croatia	42.10	9,852
8	Denmark	1,090.73	223,228	22	Slovenia	25.65	7,595
9	Belgium	499.74	124,181	23	Turkey	19.01	5,252
10	Morocco	500.59	114,251	24	Island	8.74	2,244
11	Ireland	265.86	82,075	25	Azerbaijan	7.24	1,541
12	Hungary	339.64	78,240	26	Serbia & Montenegro	3.35	1,101
13	Spain	162.18	63,916	27	Latvia	4.22	1,067
14	Sweden	323.52	56,806	28	St. Thomas Islands	1.35	325
Coke and semi-coke							
	Total	**5,257.64**	**4,930,984**				
1	Germany	1,922.43	1,837,531	16	Belarus	12.38	10,936
2	Austria	803.52	704,420	17	Egypt	13.63	8,643
3	USA	518.18	580,951	18	Portugal	9.88	8,254
4	Czech Rep.	687.83	579,950	19	Denmark	8.90	7,569
5	Romania	282.02	303,947	20	United Kingdom	8.55	3,904
6	Finland	242.60	222,122	21	Lithuania	2.15	2,282
7	France	175.38	183,854	22	Ireland	1.61	1,689
8	Norway	183.26	144,308	23	Island	2.38	1,609
9	Slovakia	162.85	131,936	24	Serbia & Montenegro	1.30	1,409
10	Hungary	60.62	54,325	25	Cyprus	1.22	934
11	Sweden	43.19	46,537	26	Niue	2.31	898
12	Belgium	48.45	42,733	27	Russia	0.88	754
13	Netherlands	28.78	18,070	28	Slovenia	0.90	679
14	Algeria	18.09	17,901	29	Macedonia	0.41	507
15	Italy	12.59	11,546	30	Azerbaijan	0.89	365
Chemical-coke products							
	Total	**573.27**	**438,636**				
1	Czech Rep.	192.16	149,311	9	South Africa	11.05	9,625
2	Germany	172.19	120,410	10	Slovakia	6.73	7,004
3	Spain	80.16	45,418	11	Italy	2.58	5,518
4	Denmark	47.59	30,612	12	Greece	3.66	3,661
5	Belgium	18.35	19,243	13	Cameroon	2.46	2,252
6	Norway	14.68	18,611	14	Romania	0.89	1,094
7	Sweden	9.76	12,948	15	France	0.44	602
8	Brazil	9.93	11,116	16	Ukraine	0.22	339

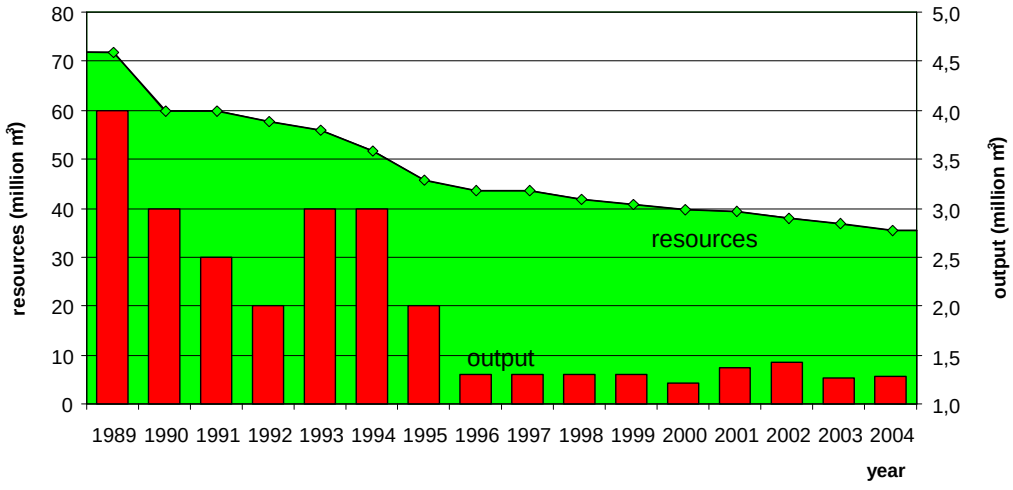
Table 24.3 Directions of Polish import of hard coal (including anthracite), coke, semi-coke and chemical-coke products

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Hard coal							
	Total	**2,503.50**	**528,511**				
1	Russia	1,495.47	274,507	5	Norway	5.06	7,992
2	Czech Rep.	619.89	157,553	6	Kazakhstan	12.42	2,147
3	Ukraine	308.74	58,280	7	China	1.54	1,840
4	Columbia	37.15	13,455	8	Belgium	1.26	555
Coke and semi-coke							
	Total	**150.97**	**123,282**				
1	Ukraine	84.80	60,520	4	Russia	10.08	7,015
2	Czech Rep.	43.11	40,085	5	Germany	4.56	4,302
3	China	8.35	11,297	6	France	0.00	24
Chemical-coke products							
	Total	**224.69**	**208,442**				
1	Czech Rep.	66.74	87,877	7	Japan	1.47	5,244
2	Ukraine	101.75	48,982	8	Belgium	2.10	3,194
3	Belarus	15.13	18,012	9	Romania	2.26	2,268
4	Slovakia	19.17	17,242	10	Hungary	0.72	1,711
5	Germany	10.80	14,972	11	France	0.64	1,661
6	Netherlands	2.81	5,877	12	Estonia	0.68	683

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 sources of helium are fields of natural gas with high nitrogen content. In the USA, gas fields containing a minimum of 0.3 % of helium are considered as helium-bearing sources.

Fig. 25.1 Helium resources and output in Poland in 1989-2004



Helium occurs in almost every gas field in the Polish Lowland, 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 exceeding 0.27 % in the Nitrogen-Separation Plant in Odolanów.

Helium output amounted to 1.29 million m^3 in 2004 (Fig. 25.1).

26. IRON

Practically, iron ore deposits are scarce in Poland. The sedimentary iron ore that was exploited in 20th century does not meet the present requirements for iron ore. The exploitation of the titanium-magnetite deposits in the Suwałki massif in northeastern Poland (at Krzemianka and Udryń) is not possible now and in the future because of the big depth of the deposits and environmental protection problems.

The total domestic demand for iron ores is met by imports. The imports amounted to 11,603 thousand tons in 2004, mainly in the form of concentrates or ores. 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			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**11,603.11**	**3,658,466**		**Total**	**2,202.78**	**2,457,441**
1	Russia	4,861.49	1,277,452	1	Germany	1,123.00	1,289,946
2	Ukraine	4,643.02	1,050,708	2	Czech Rep.	339.93	337,802
3	Czech Rep.	232.12	231,506	3	Turkey	252.48	184,222
4	Slovakia	81.01	223,461	4	Slovakia	72.69	77,108
5	Brazil	869.48	171,242	5	Spain	87.67	71,707
6	Germany	29.60	142,041	6	USA	16.38	58,750
7	Venezuela	483.79	78,067	7	Malaysia	77.19	55,482
8	China	9.36	73,876	8	France	38.42	48,235
9	Romania	26.98	61,903	9	Austria	17.55	44,382
10	Belgium	2.30	38,934	10	Sweden	15.17	40,373
11	Norway	18.48	33,800	11	Russia	9.65	34,868
12	France	14.87	29,870	12	Thailand	38.47	33,018
13	Sweden	73.21	24,489	13	Italy	16.59	21,890
14	Spain	4.60	20,899	14	Netherlands	9.37	21,503
15	Canada	126.85	20,161	15	China	22.61	15,181
16	Netherlands	2.27	17,830	16	Latvia	14.17	13,494
17	South Africa	4.57	15,822	17	Belgium	2.78	12,447
18	United Kingdom	2.72	15,773	18	Canada	3.00	11,770
19	Kazakhstan	3.19	15,487	19	United Kingdom	5.98	11,215
20	Italy	3.34	13,912	20	South Korea	1.61	10,375
21	USA	11.46	10,928	21	Finland	3.84	9,967
22	Austria	0.61	10,258	22	Hungary	1.32	9,330
23	Belarus	24.77	8,280	23	Egypt	12.30	9,254
24	Mauritania	60.01	8,092	24	Ukraine	0.60	6,007
25	Slovenia	1.72	8,060	25	Luxemburg	3.38	5,969
26	Hungary	0.43	7,680	26	Slovenia	3.59	4,473
27	Iran	1.90	4,330	27	Norway	5.76	4,296

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
28	Azerbaijan	0.04	4,221	28	Portugal	3.13	2,419
29	Georgia	1.00	4,070	29	North Korea	0.40	2,396
30	South Korea	0.12	3,969	30	Lithuania	0.51	1,928
31	Armenia	0.03	3,455	31	Indonesia	0.23	1,343
32	India	0.85	3,083	32	India	1.42	986
33	Chile	0.03	3,018	33	Belarus	0.11	915
34	Luxemburg	0.22	2,567	34	Cyprus	0.20	880
35	Macedonia	0.93	2,560	35	Romania	0.15	674
36	Denmark	0.26	2,287	36	Switzerland	0.23	575
37	Finland	2.87	2,098	37	Moldova	0.10	545
38	Switzerland	0.07	1,881	38	Denmark	0.11	502
39	Turkey	0.35	1,590	39	Cuba	0.29	270
40	Lithuania	0.19	1,173	40	Estonia	0.10	167
41	North Korea	0.15	802	41	Azerbaijan	0.05	152
42	Albania	0.22	736	42	Kyrgyztan	0.03	126
43	Egypt	0.20	683	43	Singapore	0.02	122
44	Zambia	0.00	680	44	Sierra Leone	0.13	122
45	Island	0.20	676	45	Taiwan	0.05	81
46	Bosnia & Herzegovina	0.44	640	46	Stock	0.01	38
47	Laos	0.09	585	47	Brazil	0.01	32

27. KAOLIN

The Polish term "kaolin" relates to a rock with a high content of the kaolinite mineral that 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 treatment, electrophoresis, etc.

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	**14**	**215.20**	**141.65**	**73.55**	**46.05**	**74.48**
including reserves of exploited deposits						
Total	2	82.54	82.54	–	–	74.48
including resources of not exploited deposits						
Total	10	123.46	49.91	73.55	41.67	–
Exploration	5	52.22	49.91	2.31	29.67	–
Prospecting	5	71.24	–	71.24	12.00	–
including abandoned deposits						
Total	2	9.20	9.20	–	4.38	–

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 redeposit types and occur where the mother rocks appear. Sandstones with kaolinite binder occur in the north-Sudetic depression. All the deposits are Paleogene.

The resources of kaolin raw materials amount to 215.2 million tons. The state of resources of the raw materials and the state of their management are presented in Table 27.1.

The exploitation of kaolin raw materials was conducted in the Maria III deposit near Bolesławiec and amounted to 351 thousand tons in 2004. Second being active deposit Dunino is very small one and there was no output in 2004. The demand of Polish industry is balanced by imports. Import was bigger than in 1999 and amounted to 89.1 thousand tons in 2004, mainly crude kaolin – 80.2 thousand tons and 8.9 thousand tons of burned kaolin. Export of kaolin was also in the same period. It amounted to 9.6 thousand tons of this raw material (Table 27.2).

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

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**89.05**	**46,644**		**Total**	**9.58**	**3,332**
1	Germany	32.92	13,405	1	Germany	8.12	2,715
2	United Kingdom	14.48	12,719	2	Romania	1.35	551
3	Czech Rep.	24.15	10,849	3	Slovakia	0.05	16
4	USA	4.78	4,450	4	Russia	0.00	14
5	Spain	3.71	2,605	5	Lithuania	0.00	10
6	Ukraine	7.56	1,265	6	Germany	0.02	10
7	Italy	0.28	505	7	Ukraine	0.02	7

28. LIGNITE

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

In the Paleogene measures, lignite forms single beds, lentils or complexes of beds in sediments belonging to the periods from Palaeocene to Upper Miocene. However, the most important from the economic aspect are the Middle Miocene sediments. The surface of the Paleogene 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 but together with the estimated perspective deposits of 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 13,635 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).

The exploited deposits resources constitute 13.12 % of the identified resources and amount to 1,789 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.

Table 28.1 Lignite (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**76**	**13,634.93**	**4,198.38**	**9,436.55**	**4,615.88**	**1,586.41**
including reserves of exploited deposits						
Total	10	1,788.88	1,688.42	100.46	133.26	1,551.19
including resources of not exploited deposits						
Total	61	11,836.78	2,501.33	9,335.45	4,478.35	35.22
Exploration	31	2,817.64	2,501.33	316.31	702.30	35.22
Prospecting	30	9,019.14	–	9,019.14	3,776.05	–
including abandoned deposits						
Total	5	9.28	8.64	0.64	4.27	–

The prognosis of lignite output should not include the area of Poznań graben, i.e. the deposits of Czempin, Krzywin and Gostyń. 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 1,551 million tons and constitute 86.71 % of their identified resources.

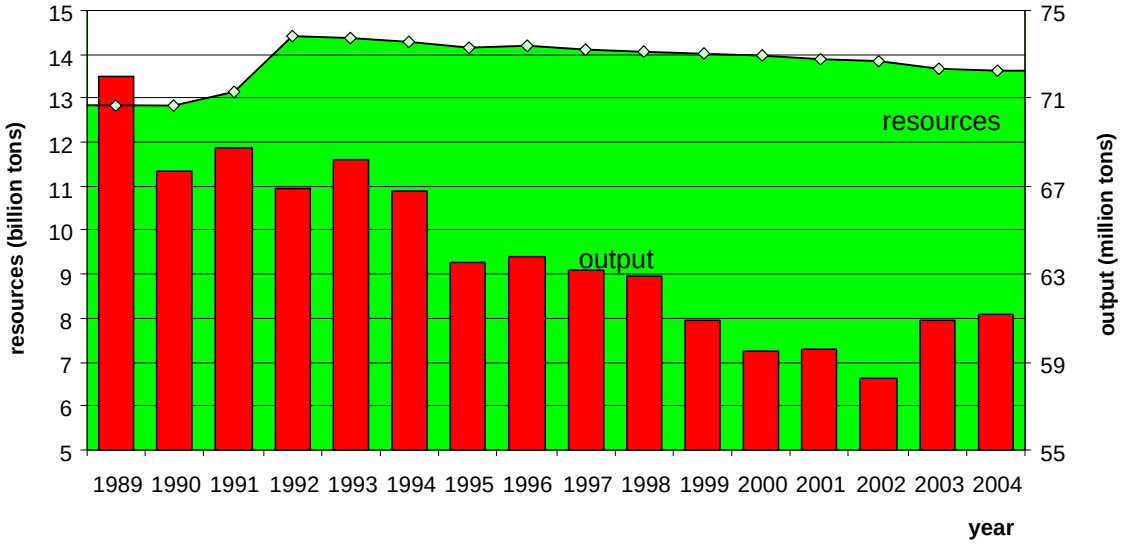
The lignite output in the period from 1989 to 2004 is shown in Fig. 28.1. In 2004, the output amounted to 61,186 thousand tons, the Bełchatów deposit accounting for 57.6 % and the Turów deposit for 17.7 %.

Almost the whole lignite output was consumed by power stations, and only 27.7 thousand tons was exported.

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 337 million m^3 of mine water, about 46.3 % comes from the Bełchatów open pit, while only 0.75 % of it is utilised.

Fig. 28.1 Lignite resources and outputin Poland in 1989-2004



29. LIMESTONES AND MARLS FOR CEMENT AND LIME INDUSTRIES

Limestone and marls used in the production of cement and lime (building and industrial lime) occur in Poland in the following regions (Plate 6):

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

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

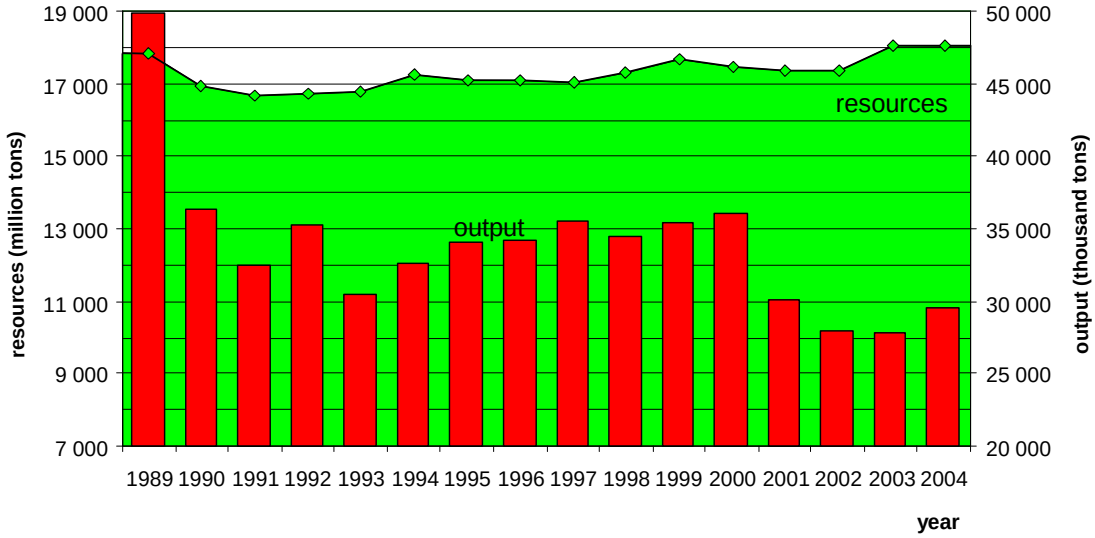
The output of calcareous raw materials amounted in 2004 to 29.6 million tons, including 18 million tons for the cement industry, and 11.6 million tons for the lime one.

Figure 29.1 shows limestone and marl resources and their output in Poland in the period 1989-2004.

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

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**177**	**18,029.32**	**9,554.33**	**8,474.99**	**1,513.02**	**3,246.30**
including reserves of exploited deposits						
Total	38	6,063.10	4,911.83	1,151.27	73.12	3,222.20
including resources of not exploited deposits						
Total	97	11,791.95	4,479.06	7,312.89	1,406.68	24.10
Exploration	61	5,417.39	4,371.87	1,045.52	738.94	24.10
Prospecting	36	6,374.56	107.19	6,267.37	667.74	–
including abandoned deposits						
Total	42	174.26	163.43	10.83	33.22	–

Fig. 29.1 Resources and output of limestones and marls for cement and lime industries in Poland in 1989-2004



The resources of limestone and marls for cement and lime industries cover the total country's demand and make possible considerable exports of limestones processed products. Exports in 2004 amounted to 1,686 thousand tons of cement and lime. Imports in the same year amounted to 707 thousand tons of cement and lime.

The magnitude, 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 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 amounted to a totally of over 90 billion tons.

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

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**707.03**	**127,787**		**Total**	**1,685.79**	**159,188**
1	Byelorussia	360.92	56,222	1	Germany	1,196.80	51,570
2	Germany	98.89	16,857	2	United Kingdom	191.02	29,130
3	Slovakia	39.74	16,141	3	Italy	17.94	21,762
4	Ukraine	78.13	11,710	4	Czech Rep.	106.15	20,283
5	Denmark	32.03	11,244	5	Norway	52.72	10,522
6	France	2.77	6,342	6	Ukraine	54.92	6,220
7	Czech Rep.	90.88	4,380	7	Netherlands	23.61	3,967
8	Netherlands	0.45	1,384	8	Russia	3.68	2,315
9	Spain	0.42	1,164	9	Lithuania	4.60	1,949
10	Belgium	1.16	835	10	Belgium	0.58	1,386
11	Croatia	0.48	781	11	Austria	2.79	1,337
12	United States	0.02	273	12	Ireland	13.97	1,099
13	Australia	1.02	141	13	Finland	3.59	1,098
14	Italy	0.02	117	14	Slovakia	1.36	1,077

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 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.

Resources of magnesites amount to 13.2 million tons. Only 3.0 million tons of the magnesites resources (23 % of the total resources) occur in the only deposit being exploited (Braszowice). The output of magnesites amounted to 52 thousand tons in 2004. This quantity did not meet the domestic demand, especially in view of the poor quality. Therefore, magnesites are imported to Poland and this import amounted to 8.1 thousand tons in 2004.

Table 30.1 Magnesites (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**6**	**13.24**	**3.32**	**9.92**	**2.18**	**2.80**
including reserves of exploited deposits						
Total	1	3.04	3.04	–	–	2.80
including resources of not exploited deposits						
Total	4	6.10	–	6.10	2.18	–
including abandoned deposits						
Total	1	4.11	0.28	3.83	–	–

Table 30.2 Directions of Polish import of magnesite and magnesite products

No	Country	Thousand tons	Thousand PLN
	Total	**8.11**	**17,261**
1	France	0.49	2,962
2	United Kingdom	1.05	2,892
3	China	1.86	2,243
4	Japan	0.31	1,561
5	USA	0.32	1,446
6	Austria	0.60	1,413
7	Ireland	1.00	1,281
8	Germany	0.48	1,205
9	Israel	0.10	1,177
10	Czech Rep.	0.31	373

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

The magnesites raw materials are used in great quantities in the production of magnesium fertilizers for agriculture. Magnesites for the refractory material industry and for the metallurgy come 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 contains also such metals that 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 tungsten) 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 metals 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	–	0.12	–	0.12
Germanium	–	0.04	–	0.04
Cadmium	–	66.45	–	66.45
Cobalt	97.02	–	–	97.02
Molybdenum	74.68	–	–	74.68
Rhenium	0.06	–	–	0.06
Thallium	–	11.41	–	11.41
Titanium (Ti)	–	–	12.00	12.00

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

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Aluminium							
	Total	**419.13**	**1,796,936**		**Total**	**164.03**	**821,628**
1	Russia	84.06	536,189	1	Germany	86.73	413,002
2	Germany	58.77	260,283	2	Austria	16.31	90,173
3	Slovakia	29.48	208,313	3	Czech Rep.	14.06	70,644
4	United Arab Emirates	22.59	162,258	4	Hungary	8.23	53,988
5	Brazil	16.05	112,426	5	France	10.26	53,252
6	Norway	8.58	61,827	6	United Kingdom	6.13	28,974
7	Slovenia	7.47	48,036	7	Italy	4.84	27,270
8	Czech Rep.	7.82	40,639	8	Slovakia	4.01	22,204
9	Spain	43.95	39,161	9	Sweden	3.13	13,228
10	Sweden	6.34	29,541	10	Japan	0.80	6,402
11	Italy	18.65	28,876	11	Netherlands	1.46	5,379
12	Jamaica	32.86	26,475	12	Spain	1.20	4,944
13	Hungary	15.99	24,168	13	Denmark	1.41	4,801
14	Belgium	3.73	23,723	14	Croatia	0.72	4,744
15	Tajikistan	3.50	22,907	15	Slovenia	0.62	4,039
16	China	12.57	20,247	16	Indonesia	0.43	2,911
17	France	3.11	19,234	17	South Africa	0.32	2,611
18	Netherlands	3.59	18,329	18	Luxemburg	0.32	2,085
19	Argentina	2.24	16,097	19	Switzerland	0.31	1,807
20	Austria	2.40	14,734	20	Estonia	0.28	1,728
21	Ukraine	13.90	14,471	21	Lithuania	0.67	1,390
22	Greece	10.03	9,538	22	Taiwan	0.20	1,073

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
23	Moldova	1.92	8,932	23	Mexico	0.12	806
24	United Kingdom	0.83	8,742	24	Latvia	0.16	777
25	Canada	1.23	8,456	25	Belgium	0.41	717
26	Lithuania	2.35	6,748	26	India	0.12	593
27	USA	0.67	5,739	27	China	0.28	538
28	Bosnia &Herzegovina	1.09	4,064	28	Ukraine	0.16	340
29	Japan	0.22	3,493	29	Algeria	0.02	238
30	Mozambique	0.37	2,729	30	Greece	0.20	237
31	Latvia	0.37	2,599	31	Iran	0.02	180
32	Romania	1.39	2,492	32	Azerbaijan	0.02	147
33	South Africa	0.32	816	33	Norway	0.01	130
34	Kazakhstan	0.01	803	34	Thailand	0.02	126
35	Island	0.10	736	35	Belarus	0.03	52
36	Bulgaria	0.13	721	36	Russia	0.02	45
37	Denmark	0.09	567	37	Bulgaria	0.01	30
Antimony							
	Total	**1.12**	**11,590**		**Total**	**0.01**	**122**
1	China	1.02	9,977	1	Ukraine	0.01	80
2	Japan	0.05	999	2	Slovakia	0.00	14
3	Italy	0.04	367	3	Romania	0.00	12
Chromium							
	Total	**15.77**	**36,264**		**Total**	**3.51**	**10,585**
1	South Africa	9.80	9,728	1	Italy	1.90	4,359
2	Germany	1.30	9,227	2	United Kingdom	0.18	1,186
3	Kazakhstan	1.75	7,647	3	USA	0.10	974
4	France	0.10	1,155	4	Spain	0.31	794
5	Netherlands	0.27	1,054	5	Germany	0.47	657
6	Belgium	0.08	1,022	6	Belarus	0.01	499
7	Hungary	0.04	990	7	France	0.05	394
8	United Kingdom	0.12	962	8	Netherlands	0.03	327
9	Pakistan	0.85	906	9	Czech Rep.	0.13	255
10	Italy	0.36	836	10	South Korea	0.09	170
11	Russia	0.27	783	11	Lithuania	0.07	153
Cobalt							
	Total	**0.08**	**9,938**		**Total**	**0.02**	**682**
1	USA	0.02	3,053	1	USA	0.01	265
2	Finland	0.02	2,565	2	Ukraine	0.00	147
3	Belgium	0.01	1,714	3	United Kingdom	0.00	120
4	United Kingdom	0.01	1,104	4	Germany	0.01	73
5	Germany	0.00	630	5	Belgium	0.00	47
Magnesium							
	Total	**83.30**	**100,601**		**Total**	**5.63**	**5,214**
1	China	13.06	27,242	1	Finland	1.48	1,554
2	Brazil	28.12	24,487	2	Germany	0.77	523
3	Slovakia	21.25	15,913	3	Czech Rep.	0.69	503
4	Germany	6.88	8,105	4	Ukraine	0.10	398

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
5	France	2.75	6,596	5	Italy	0.51	384
6	Australia	4.11	4,332	6	Belarus	0.21	323
7	Netherlands	2.17	3,219	7	Switzerland	0.31	299
8	Austria	0.67	2,752	8	Spain	0.50	293
9	Canada	0.10	1,549	9	Belgium	0.24	179
10	Spain	0.96	857	10	Tunisia	0.18	134
11	Ireland	0.50	656	11	Slovakia	0.19	120
12	Israel	0.17	622	12	USA	0.02	93
13	Greece	0.54	582	13	Hungary	0.10	79
14	USA	0.13	554	14	United Kingdom	0.10	64
15	Italy	0.09	527	15	France	0.07	61
16	North Korea	0.85	520	16	Lithuania	0.03	42
17	Czech Rep.	0.38	518	17	Russia	0.02	40
Manganese							
	Total	**212.81**	**109,220**		**Total**	**0.12**	**821**
1	Australia	107.71	50,797	1	Latvia	0.02	419
2	Brazil	53.74	21,972	2	Estonia	0.02	142
3	Belgium	2.35	5,331	3	Russia	0.04	61
4	Ireland	1.69	5,061	4	Belgium	0.01	48
5	South Africa	16.35	4,677	5	Serbia & Montenegro	0.00	47
6	Ukraine	20.28	3,765	6	Germany	0.00	39
7	China	0.65	3,237	7	United Kingdom	0.00	21
8	Greece	0.46	2,070	8	Sweden	0.00	9
9	USA	0.40	1,993	9	Hungary	0.00	7
10	Germany	0.27	1,764	10	Denmark	0.006	7
11	Gabon	1.33	1,411	11	Czech Rep.	0.001	6
12	Norway	0.85	1,320	12	Bulgaria	0.003	5
13	India	1.15	1,172	13	Lithuania	0.002	4
14	Spain	0.14	1,019	14	Belarus	0.002	3
15	Russia	2.62	1,009	15	Ukraine	0.001	1
16	France	0.67	1,000				
17	Columbia	0.55	652				
18	Georgia	1.49	560				
Molybdenum							
	Total	**0.03**	**3,305**		**Total**	**0.01**	**951**
1	China	0.02	1,455	1	Czech Rep.	0.01	745
2	Netherlands	0.01	721	2	Germany	0.00	152
3	Russia	0.00	589	3	Russia	0.00	14
Precious metals and their compounds (excludes gold and platinum) (tons)							
	Total	**108.62**	**49,762**		**Total**	**153.80**	**27,114**
1	United Kingdom	49.45	16,974	1	Germany	82.44	15,224
2	USA	25.50	14,027	2	United Kingdom	57.50	7,245
3	Germany	23.45	11,773	3	USA	2.99	2,511
4	Switzerland	0.10	2,757	4	Czech Rep.	2.52	883
5	France	3.29	1,842	5	Italy	3.61	347
6	Czech Rep.	0.37	1,529	6	Russia	0.48	267

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Gold (tons)							
	Total	**0.22**	**12,723**		**Total**	**4.07**	**8,810**
1	Germany	0.18	9,087	1	Germany	4.06	8,759
2	Italy	0.00	3,093	2	Lithuania	0.00	50
Platinum (tons)							
	Total	**0.19**	**17,314**		**Total**	**31.02**	**23,819**
1	United Kingdom	0.10	9,143	1	United Kingdom	9.42	8,354
2	Germany	0.02	3,033	2	France	0.19	4,357
3	Russia	0.03	2,957	3	Germany	21.17	3,878
4	Slovakia	0.02	1,502	4	Russia	0.05	3,650
5	Netherlands	0.00	654	5	Bulgaria	0.02	1,832
6	USA	0.00	18	6	Slovakia	0.01	1,537
Tungsten (tons)							
	Total	**82.48**	**3,392**		**Total**	**36.42**	**822**
1	Russia	40.00	1,261	1	Germany	27.64	529
2	Czech Rep.	24.36	1,239	2	Netherlands	8.33	201
3	China	16.20	623	3	Sweden	0.40	86

32. NATURAL AGGREGATES

The resource base of natural aggregates exceeds 14.6 billion tons in 5,118 deposits. The deposits are distributed throughout Poland in all voivodeships.

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

Plate 8 presents the localization of natural aggregates deposits with resources over 1 million tons in each. There are 1,244 such deposits. Their total resources constitute almost 94 % of the domestic resources. The plate does not present localization of small deposits of local importance only. Despite their large number (3,875), the total resources amount to only 6 % 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 voivodeships located along the south state border (from Zielona Góra to Nowy Sącz), i.e. in the so-called Sudetic-Carpathian zone are the richest in natural aggregate deposits. This zone is featured by a large potential and, especially in the Sudetic area, by a good quality of gravels. The most important deposits occur in the river origin (terrace sediments of mountain and sub-mountain rivers). In the Sudetic part mainly sand-gravel deposits of Pleistocene upper 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 that depreciates their 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 and limestone rocks of Scandinavian provenance with an admixture of weaker and even detrimental local rocks, such as: limestone, flintstone and siliceous sandstone.

Fig. 32.1 The distribution of natural aggregate resources in Poland in 2004

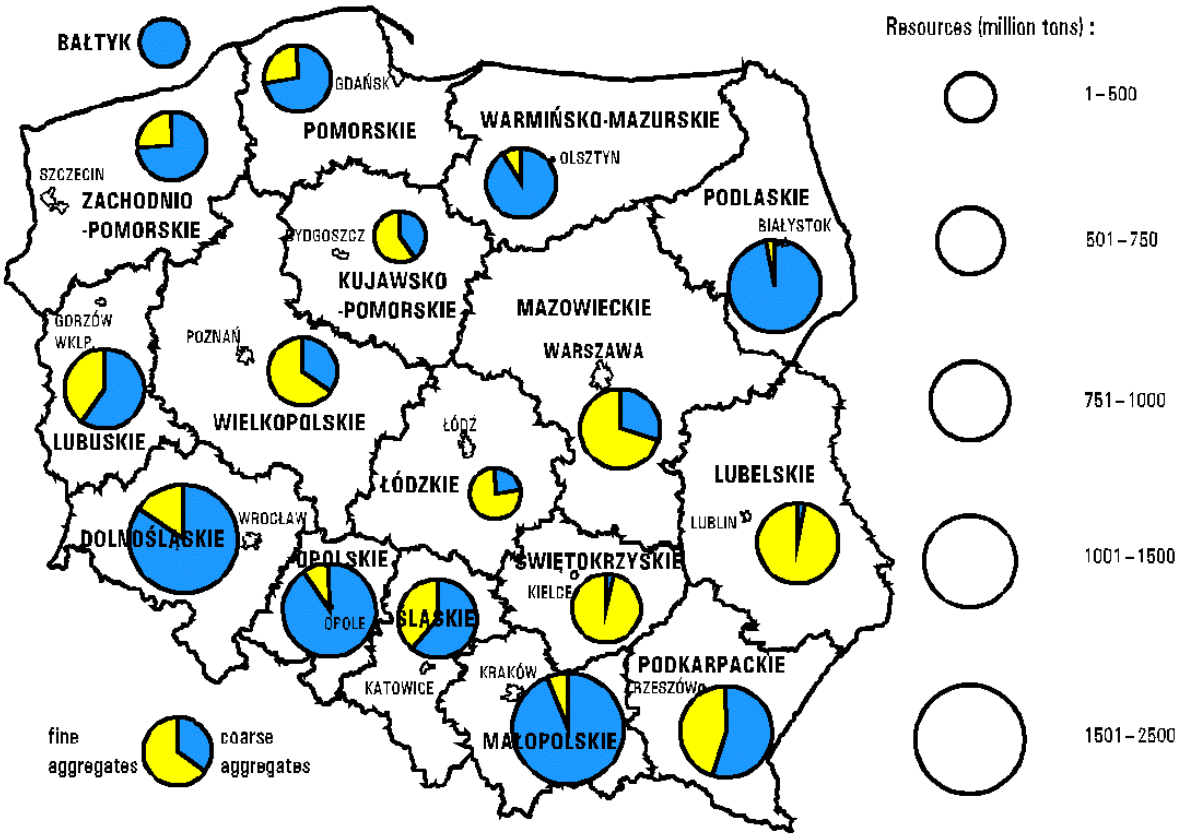
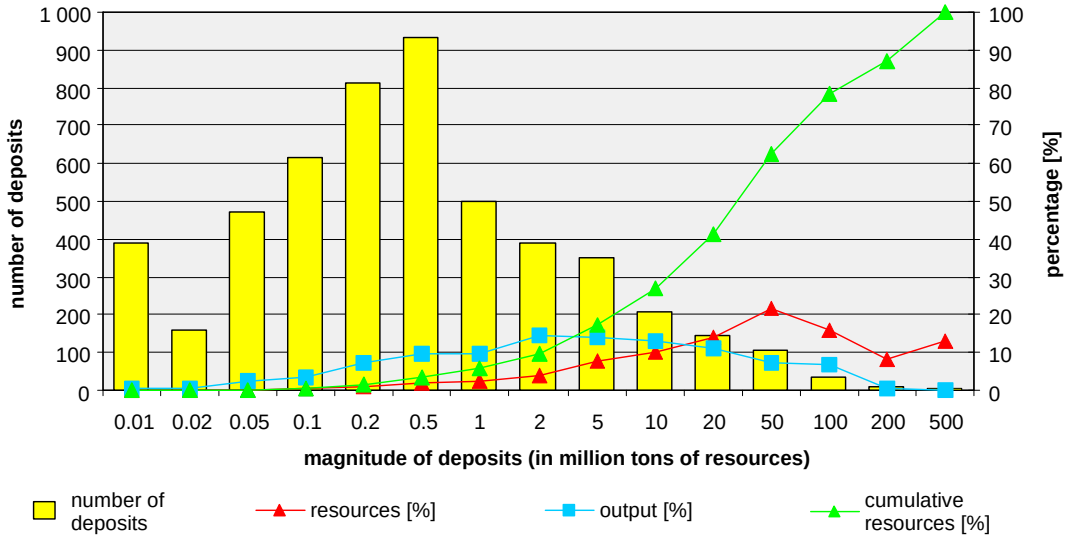


Fig. 32.2 Frequency of resources magnitude in natural aggregates deposits in Poland in 2004



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.

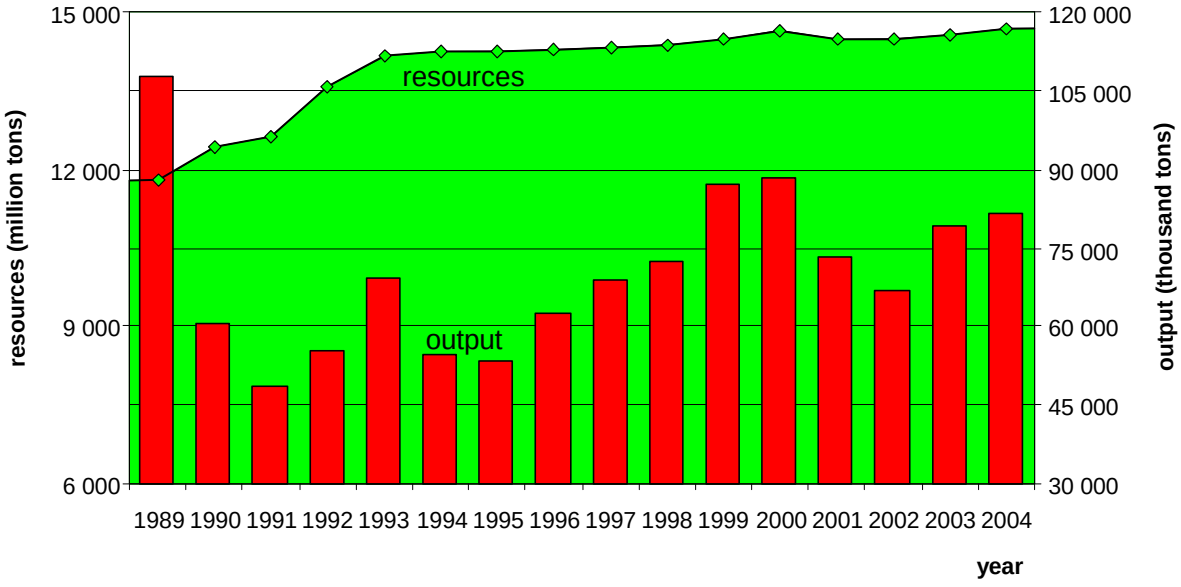
The southern part of the Baltic Sea (Słupsk Shoal) is famous for marine deposits of natural aggregates.

In Poland, there are 1,893 operating pits with total resources of about 3.3 billion tons, which constitute 22.6 % of the raw material potential (Table 32.1). The output from the deposits of resources amounting to 0.5-20 million tons constitutes the largest part (72 %) of the total natural aggregates output (Fig. 32.2).

Table 32.1 Natural aggregates (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**5,118**	**14,637.31**	**6,451.62**	**8,185.69**	**390.66**	**2,191.30**
including reserves of exploited deposits						
Total	1,893	3,301.73	2,805.71	496.02	66.75	2,039.67
including resources of not exploited deposits						
Total	1,997	10,388.76	2,923.42	7,465.34	257.71	137.91
Exploration	1,652	3,152.46	2,818.91	333.55	102.32	131.37
Prospecting	345	7,236.30	104.51	7,131.79	155.39	6.54
including abandoned deposits						
Total	1,228	946.82	722.50	224.32	66.20	13.72

Fig. 32.3 Natural aggregates resources and output in Poland in 1989-2004



The aggregate output was diversified in the period between 1989 and 2004 (Fig 32.3) and varied from 48.5 million tons in 1991 to 107.7 million tons in 1989, and now it amounts to 81 million tons. This shows the potential that can meet the major demand in future.

In 2004, exports of coarse-grained natural aggregates amounted to 188 thousand tons that constitutes only 5 % of the exports in 1995, and 88 % of 2003, but as in the previous years the natural aggregates were exported to the same country - Germany (97.8 %). Besides, 72 thousand tons of siliceous and quartz sands (more 35 % than in the last year) were exported mainly to two countries (Czech Republic 68 % and Slovakia 20 %). Export of sands other than siliceous and quartz ones amounted to 47 thousand tons (67 % of the 2003, and 7 % of the 1995 level), the sands were exported mainly to Czech Republic (64 %) and Germany (32 %).

33. NATURAL GAS

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

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 nitrogen contents of 95.7 - 97.6 % and only 3.1 % of methane.

The resources in each region have changed in recent years due to the new gas resources found in the Brońsko, Kościan, BMB and 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 %.

In the Carpathian Foredeep, the gas fields occur in the Jurassic, Cretaceous and Miocene sediments. The gas has a high methane and low nitrogen content (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. The recoverable proven resources of natural gas amounted to 154,355 million m^3 (as of 31 December 2004).

The resources of the exploited gas fields amounted to 127,722 million m^3, which constituted 82.7 % of their total amount. From the total of 256 gas fields 183 fields (71.5 %) are under exploitation (Plate 1).

The total economic reserves amounted to 80,723 million m^3 in 2004.

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 2004 six fields with a total reserve of 4,749 million m^3 had been designated for underground stores. The gas output amounted to 5,228.92 million m^3 in 2004. The contribution of the particular regions to this output was as follows: the Lowland 66 %, the Carpathian Foredeep 33 %, the Carpathians only 0.7 % and Polish economic zone of the Baltic Sea below 0.5 %.

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	*** 256**	**154,355**	**107,330**	**47,025**	**2,223**	**80,723**
	**** 68**	**25,651**	**11,946**	**13,705**	**657**	**9,968**
	***** 185**	**122,140**	**90,625**	**31,515**	**1,567**	**66,006**
	****** 6**	**4,758**	**4,758**	**–**	**–**	**4,749**
including reserves of exploited fields						
Total	183	127,722	96,102	31,620	22	80,268
	58	18,920	9,501	9,419	7	9,968
	128	104,044	81,843	22,201	16	65,551
	6	4,758	4,758	–	–	4,749
the Carpathians	33	1,127	697	430	19	561
	22	116	21	95	3	10
	15	890	555	335	16	429
	1	122	122	–	–	121
the Carpathian Foredeep	65	43,521	31,223	12,298	1	19,356
	6	183	182	1	1	7
	58	42,799	30,502	12,297	–	18,819
	4	539	539	–	–	530
Polish Lowland	84	82,032	63,556	18,476	2	59,305
	29	17,580	8,672	8,907	2	8,905
	55	60,355	50,786	9,569	–	46,302
	1	4,098	4,098	–	–	4,097
Baltic	1	1,042	626	416	–	1,044
	1	1,042	626	416	–	1,044
	–	–	–	–	–	–
including resources of not exploited fields						
Total	58	26,433	11,228	15,205	2,073	454
	8	6,722	2,446	4,276	650	–
	50	17,905	8,782	9,123	1,423	454
the Carpathians	2	240	240	–	73	–
	–	–	–	–	–	–
	2	240	240	–	73	–
the Carpathian Foredeep	11	1,784	101	1,683	3	454
	–	–	–	–	–	–
	11	1,784	101	1,683	3	454
Polish Lowland	42	20,489	10,887	9,602	1,997	–
	6	4,608	2,446	2,162	650	–
	37	15,882	8,441	7,440	1,347	–
Baltic	3	3,920	–	3,920	–	–
	2	2,114	–	2,114	–	–
	–	–	–	–	–	–
including abandoned fields						
Total	15	200	–	200	128	–
	2	9	–	9	–	–
	7	191	–	191	128	–
the Carpathians	2	–	–	–	92	–
	–	–	–	–	–	–
	1	–	–	–	92	–
the Carpathian Foredeep	4	–	–	–	36	–
	–	–	–	–	–	–
	2	–	–	–	36	–
Polish Lowland	9	200	–	200	–	–
	2	9	–	9	–	–
	4	191	–	191	–	–

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

The gas resources and their exploitation in Poland for the period between 1989 and 2004 are shown in Fig 33.1.

In 2004, the gas output covered 43.2 % of the country's demand. The deficit was balanced by imports that amounted to 6,226 million m^3 (mainly from Russia 59.6 %). The directions and quantities of gas imports and exports are shown in Table 33.2.

Prognostic gas resources, estimated at about 650 billion 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 1989-2004

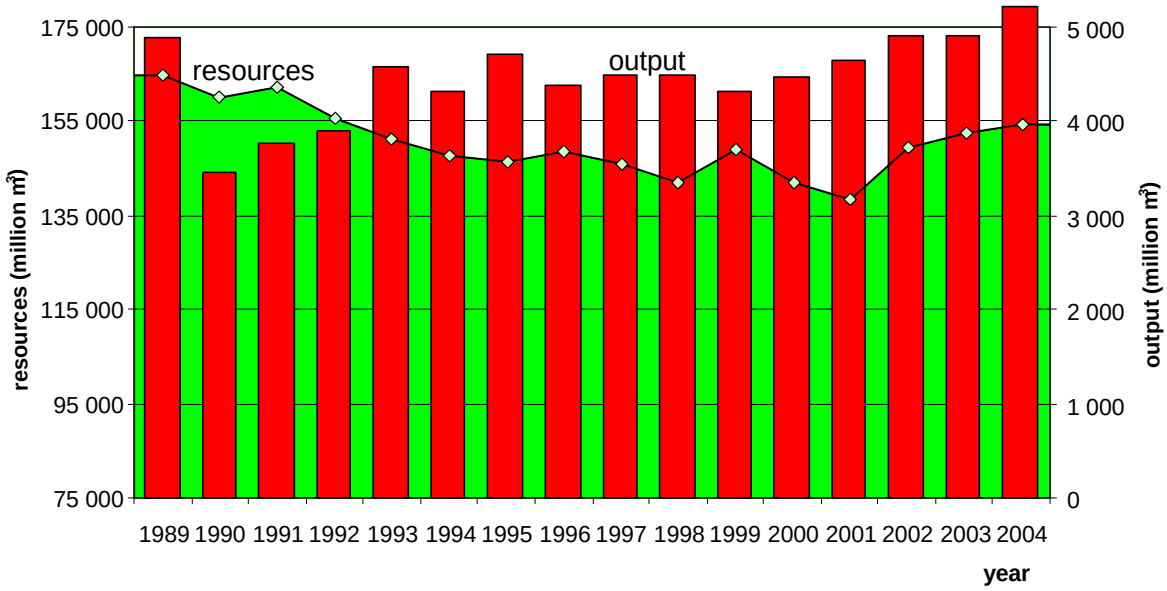


Table 33.2 Directions of Polish imports and exports of natural gas

Import				Export			
No	Country	Million m^3	Thousand PLN	No	Country	Million m^3	Thousand PLN
	Total	**6,226**	**4,904,000**		**Total**	**30**	**12,368**
1	Russia	3,712	2,883,076	1	Germany	30	12,164
2	Kazakhstan	997	847,473	2	Sweden	0	203
3	Turkmenistan	605	381,735				
4	Norway	350	330,772				
5	Germany	316	296,938				
6	Uzbekistan	149	89,521				
7	Hungary	85	58,647				
8	Lithuania	12	15,640				

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 output ended in 1983, when exploitation of the Szklary deposit was terminated.

The intrinsically economic resources of the deposit explored in detail 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 2004 to 2.16 thousand tons of nickel sulfate.

The exports of nickel amounted in 2004 to 2.53 thousand tons and imports to 3.32 thousand tons (Table 34.1).

Table 34.1 Directions of Polish imports and exports of nickel

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**3.32**	**150,475**		**Total**	**2.53**	**38,707**
1	Russia	1.08	57,826	1	Czech Rep.	1.16	22,869
2	USA	0.69	22,787	2	Germany	0.80	7,144
3	Norway	0.25	13,557	3	Finland	0.29	3,377
4	Germany	0.26	12,596	4	Ukraine	0.09	3,330
5	Slovakia	0.17	8,988	5	United Kingdom	0.03	642
6	Finland	0.21	7,669	6	Russia	0.02	359
7	United Kingdom	0.14	7,648	7	USA	0.03	328
8	France	0.22	7,457	8	Netherlands	0.05	216
9	Canada	0.04	2,698	9	Slovakia	0.00	134
10	Denmark	0.04	1,958	10	Belarus	0.01	78
11	Netherlands	0.06	1,648	11	Austria	0.04	63
12	Belgium	0.04	1,402	12	France	0.00	47
13	Brazil	0.02	1,367	13	Lithuania	0.00	33
14	Ireland	0.01	985	14	Latvia	0.00	32
15	Austria	0.06	856	15	Moldova	0.00	30
16	Italy	0.02	762	16	Estonia	0.00	22

35. PEAT

There are three types of peat: fen, high bog and intermediate. Fen peat is most common in Poland. It occurs in the river valleys and on the lake coasts on Polish Lowlands. This 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 peats join characteristics of both – fen and high bog peat.

Depending on it 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 (balneology) for bathing and compresses.

For agricultural purposes peat pH must be no more than 4. Contains of ash will be maximum 25 %. The better quality peat 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 capacity of water more than 75 %. The capacity of active organic compounds would be high and it would be microbiologically clean.

There is about 1.2 million hectare of peat bogs in Poland (4.2 % of area of country). They contain 17 billions m^3 of peat and concentrate mainly in Northern Poland (70 % of peat bogs). For nearly 50 thousands of peat bogs reconnaissance has been done. Near 18 thousands of them are potentially possible for exploitation, and 800 was or is exploited. These deposits will be verified.

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	**183**	**76.58**	**64.23**	**12.35**	**8.32**	**31.27**
including reserves of exploited deposits						
Total	79	34.53	34.26	0.27	6.15	24.52
including resources of not exploited deposits						
Total	87	40.86	28.78	12.08	2.18	6.74
Exploration	70	28.79	28.78	0.01	2.18	6.74
Prospecting	17	12.07	–	12.07	–	–
including abandoned deposits						
Total	17	1.19	1.19	–	–	0.01

In 2004 exploitation of peat from deposits that are shown in this report was 844 thousand tons, including 16 thousand tons of health care peat.

Imports of peat amounted to 60 thousand tons and exports to 43.7 thousand tons.

36. PHOSPHORITES

Phosphorite deposits lie in the northeastern surrounding of the Holy Cross Mountains, in the outcrops of Albian sediments (Plate 4).

The thickness of phosphorite-bearing measures ranges from 0.2 to 4.0 m. These 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 varies 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 – concretions 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 material is covered by imports. Imports of phosphorites, phosphate fertilizers and phosphate compounds amounted in 2004 to 1,915.3 thousand tons. At the same time exports of these materials amounted to 41.6 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			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Phosphorites							
	Total	**1,885.35**	**315,242**		**Total**	**0.51**	**201**
1	Morocco	991.78	133,285	1	Czech Rep.	0.51	194
2	Jordan	334.80	73,729	2	Germany	0.00	6
3	Tunisia	340.50	60,834	3	Ukraine		
4	Russia	80.87	20,617				
5	Syria	83.61	16,325				
6	Algeria	32.35	5,423				
7	Togo	21.35	4,897				
Phosphate fertilizers							
	Total	**6.62**	**5,051**		**Total**	**25.72**	**13,717**
1	Russia	1.94	2,584	1	Germany	18.35	10,705
2	Germany	4.22	1,421	2	Czech Rep.	5.49	1,784
3	China	0.17	499	3	Denmark	1.48	1,041
Phosphate compounds							
	Total	**23.32**	**64,774**		**Total**	**15.24**	**26,400**
1	Austria	0.99	14,321	1	Germany	4.65	6,543
2	Germany	3.81	13,945	2	Netherlands	3.57	5,719
3	Finland	9.05	10,825	3	Czech Rep.	1.22	2,118
4	Netherlands	1.03	5,339	4	Hungary	0.71	1,837
5	Spain	1.17	3,922	5	Ukraine	0.58	1,476
6	Czech Rep.	1.80	3,295	6	Finland	0.71	1,229
7	France	0.68	2,869	7	Denmark	0.90	1,222

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 shale) and also as a component of refractory mortars (quartzic shale).

In Poland the shale deposits occur in the Sudetes (Plate 7). The total resources of the 5 deposits explored here amount to almost 23.88 million tons. Two of these deposits are in exploitation and their total resources amount to 22.59 million tons and their economic reserves have been estimated at only 10.27 million tons.

The output of shale amounted to 30 thousand tons in 2004, all of them were used as bituminous board dusting agent.

38. POTASSIUM-MAGNESIUM SALTS

Potassium-magnesium salts were found in bedded Zechstein measures, in 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 %. Four deposits have been explored so far with total inferred resources amounted to 597 million tons (51 million tons of K_2O).

In the Kłodawa salt dome salts of chloride-carnalite 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. Carnalite salts are polluted, and the average K_2O content amounts to 8.5 % and that of MgO – 8.1 %. The explored carnalite salt resources in the Kłodawa salt dome amount to 72 million tons.

The state of identification of 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-magnesium salts, potassium fertilizers and potassium compounds

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**1,119.73**	**500,876**		**Total**	**10.35**	**16,322**
1	Belarus	652.19	287,673	1	Germany	3.99	7,176
2	Germany	155.07	89,587	2	Switzerland	1.15	1,608
3	Russia	280.83	80,153	3	Czech Rep.	0.75	1,343
4	Belgium	12.25	11,476	4	Finland	0.60	1,092
5	Israel	4.91	9,211	5	Russia	0.36	884
6	Chile	3.20	4,713	6	Netherlands	0.31	550
7	France	2.08	4,689	7	Denmark	1.39	548
8	Czech Rep.	2.64	4,563	8	Austria	0.31	476
9	Denmark	1.46	2,088	9	Slovenia	0.23	470
10	United States	0.61	1,469	10	France	0.24	389
11	China	0.26	915	11	Hungary	0.14	211
12	South Korea	0.23	667	12	Singapore	0.12	194
13	Italy	0.15	637	13	Italy	0.09	182
14	Lithuania	0.39	515	14	Belgium	0.09	174

The last output of potassium salt in Kłodawa mine was in 1999 and amount 10.9 thousand tons.

The country's demand for this raw material is covered by import. In 2004, 1,119.73 thousand tons of potassium salts, potassium fertilizers and potassium compounds were imported, and 10.35 thousand tons of these products were exported.

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

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 materials are aeolian sands, characterised by a high content of silica, good grain segregation and roundness as well as low contents 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 402 million m^3 (which is equivalent to 723 million tons of weight). Out of the total quantity, 134 million m^3 (241 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 (mln m^3)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**57**	**134.28**	**43.11**	**91.17**	**1.74**	**13.15**
including reserves of exploited deposits						
Total	14	19.12	14.86	4.26	0.12	12.43
including resources of not exploited deposits						
Total	37	110.80	23.89	86.91	1.09	0.72
Exploration	13	29.88	23.89	5.99	0.62	0.72
Prospecting	24	80.93	–	80.93	0.47	–
including abandoned deposits						
Total	6	4.37	4.37	–	0.53	–

The resources of quartz sands for cellular concretes production explored in detail amount to 32.1 % of the total resources of the raw material, and 14.2 % of the resources occurring in deposits in exploitation.

The economic reserves calculated for 14 deposits amount to 13.1 million m^3.

The magnitude of the output of quartz sands for cellular concrete production, for the last sixteen years is presented in Fig 39.1. The raw material output amounted to 380 thousand m^3 in 2004 (35 % of the output in 1989).

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 51.2 % of the total resources. The exploited represent 21 % of the total resources. The economic reserves calculated for 28 deposits amount 31.67 million m^3.

Table 39.2 Quartz 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	**103**	**268.11**	**137.33**	**130.78**	**6.13**	**31.67**
including reserves of exploited deposits						
Total	32	56.19	54.31	1.88	0.45	31.67
including resources of not exploited deposits						
Total	47	182.17	58.01	124.16	2.10	–
Exploration	24	59.44	58.01	1.43	2.10	–
Prospecting	23	122.73	–	122.73	–	–
including abandoned deposits						
Total	24	29.75	25.01	4.74	3.58	–

The magnitude of the output of quartz sands for production of lime-sand brick in the last sixteen years is presented in Fig 39.2. In 2004, the output of the raw material amounted to 540 thousand m^3 and was lower than in the preceding years (25 % of the output in 1989).

With the common occurrence 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 quartz sands for production of cellular concrete in Poland in 1989-2004

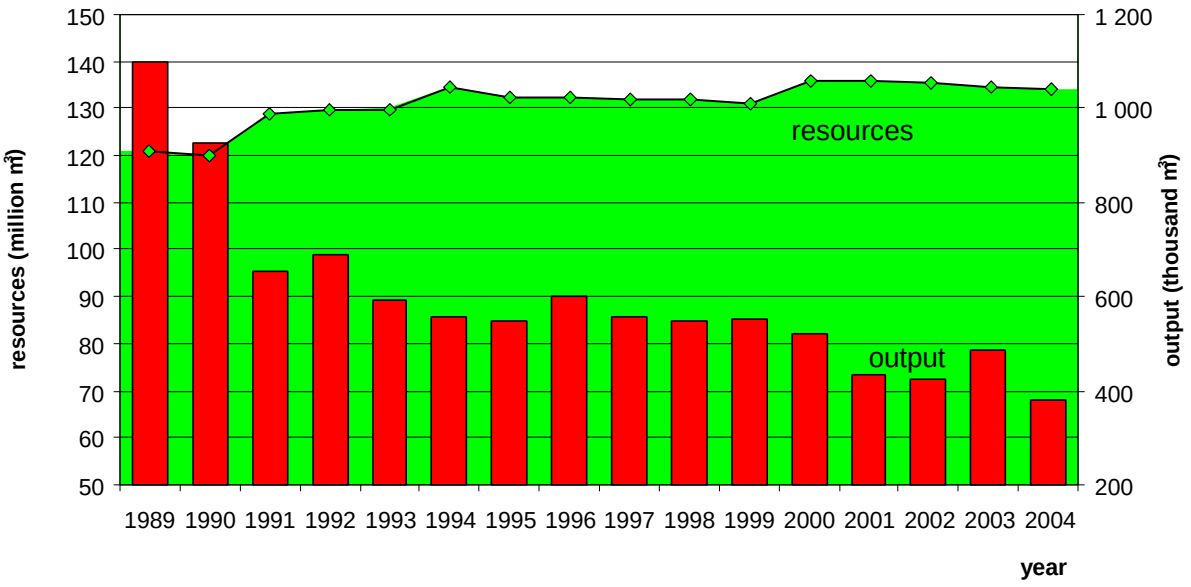
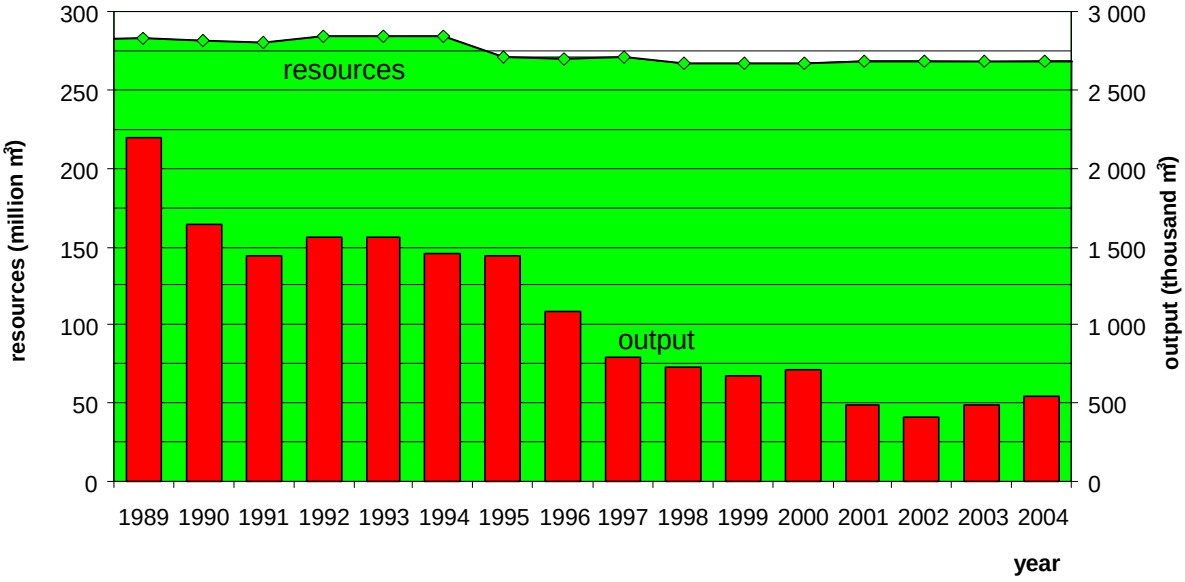


Fig. 39.2 Resources and output of quartz sands for production of lime-sand brick in Poland in 1989-2004



40. REFRACTORY CLAYS

In the refractory materials industry clays are used which are called, for short, refractory clays. These are kaolin clays of high refractory properties (above 1,500ºC) 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.

The refractory clays resources amount to 55.64 million tons. The state of these resources identification is very high. The resources explored in detail amount to 98.72 % of the total explored resources. The reserves of deposits in exploitation amount to 6.34 % of the total explored resources. The economic reserves amount to 3.53 million tons.

Table 40.1 Refractory clays (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**17**	**55.64**	**54.93**	**0.71**	**110.34**	**3.53**
including reserves of exploited deposits						
Total	3	4.83	4.49	0.34	0.89	3.53
including resources of not exploited deposits						
Exploration	6	48.62	48.47	0.15	106.02	–
including abandoned deposits						
Total	8	2.19	1.97	0.22	3.44	–

The refractory clays output amounted to 150 thousand tons in 2004 and about 81 % of the total output came from the Rusko-Jaroszów deposit.

Exports of the refractory clays, mortars and refractory masses amounted to 29.39 thousand tons in 2004 and imports of the clays amounted to 280.54 thousand tons (Table 40.2).

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

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**280.54**	**103,442**		**Total**	**29.39**	**34,499**
1	Germany	10.19	29,200	1	Czech Rep.	12.54	7,772
2	Ukraine	250.25	23,748	2	Ukraine	2.16	6,632
3	United Kingdom	2.57	14,870	3	Germany	2.61	4,138
4	Austria	4.57	8,053	4	Belarus	1.54	3,030
5	France	1.61	5,095	5	Russia	2.62	2,972
6	Sweden	1.84	3,686	6	Austria	0.63	1,863
7	Italy	1.42	3,481	7	Slovakia	0.76	1,361
8	Czech Rep.	4.18	2,922	8	Latvia	1.72	1,303
9	USA	0.20	2,630	9	Kazakhstan	1.74	1,050
10	China	1.31	2,573	10	Greece	0.25	653
11	Belgium	0.36	2,407	11	United Kingdom	0.39	648
12	Netherlands	0.58	1,978	12	Romania	0.21	626
13	Slovakia	0.73	1,267	13	Serbia & Montenegro	0.09	431

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 Paleogene ones and form irregular 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)

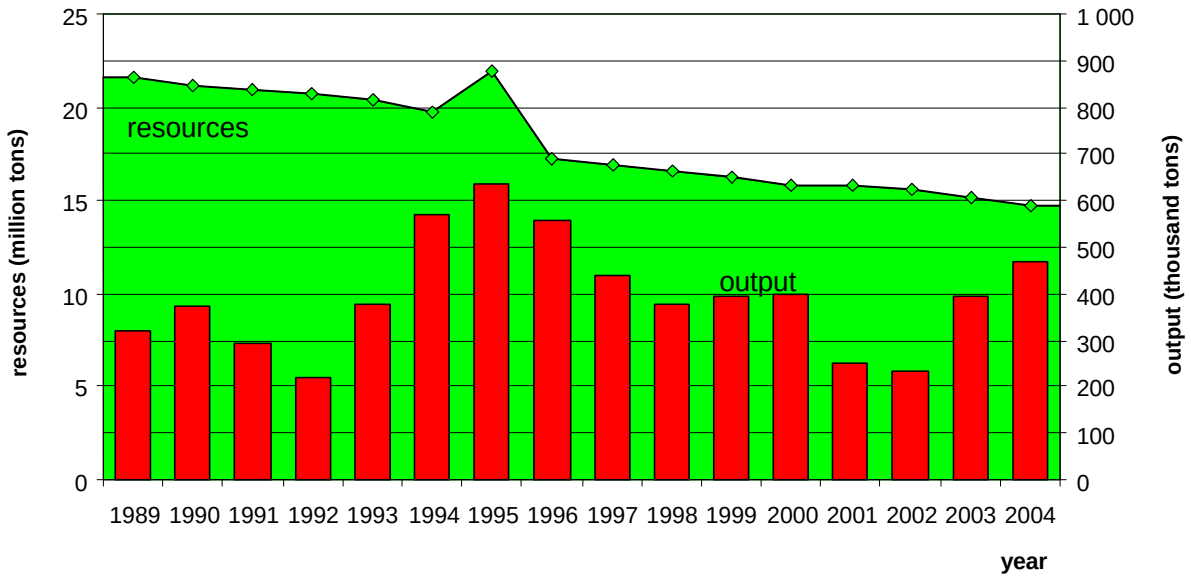
Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**19**	**14.75**	**6.51**	**8.24**	**4.74**	**7.87**
including reserves of exploited deposits						
Total	1	7.87	2.66	5.21	–	7.87
including resources of not exploited deposits						
Total	7	5.95	3.23	2.72	3.84	–
Exploration	6	5.25	3.23	2.02	3.84	–
Prospecting	1	0.70	–	0.70	–	–
including abandoned deposits						
Total	11	0.93	0.62	0.32	0.90	–

The resources of refractory quartzites amount to 14.7 million tons, of which 7.9 million tons are resources in deposits being exploited which constitute 53.7 % of the total resources of the raw material. The economic reserves amount to 7.9 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 471 thousand tons in 2004 (Fig. 41.1)

Export of quartzites amounted to 22 thousand tons in 2004.

Fig. 41.1 Refractory quartzites resources and output in Poland in 1989-2004



42. 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) and 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 intrinsically economic resources. In 2004, 100 % of the whole country salt was exploited there.

Some deposits, lying in the southern salt region, have been exploited since the Middle Ages (Wieliczka-Bochnia – historical notes regarding their exploitation exist since the 12th century), but others have been explored after the Second World War. The latter have reach resources and have not been exploited as yet. The southern region accounts for 5.4 % of the explored intrinsically economic rock salt resources.

In the pre-Sudetic monocline, 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 magnitude of rock salt resources and state of their identification and management are presented in Table 42.1.

Table 42.1 Rock salt (million tons)

Specification	Number of deposits	Reserves/resources				
		I E R			Potentially economic	Economic reserves
		Total	Exploration	Prospecting		
Total resources	**19**	**80,187.64**	**41,364.05**	**38,823.59**	**23,368.50**	**4,357.32**
including reserves of exploited deposits						
Total	5	11,200.42	7,371.13	3,829.29	2,725.95	4,357.32
including resources of not exploited deposits						
Total	11	68,799.34	33,913.24	34,886.10	20,455.30	–
Exploration	4	24,603.88	22,952.81	1,651.07	9,990.28	–
Prospecting	7	44,195.46	10,960.43	33,235.03	10,465.02	–
including abandoned deposits						
Total	3	187.88	79.68	108.20	187.25	–

The output from documented resources in 2004 amounted to 3,988 thousand tons. Apart from it 195.26 thousand tons of rock salt was exploited during mine-preparing works from copper mine Sieroszowice and about 65 thousand tons was produced from brine from hard coal mines in Desalination Factory Dębieńsko.

Actually four salt mines are in operation, including the only one that is a shaft mine (Kłodawa) exploiting dry salt suitable for alimentary purposes. Exploitation of historic Wieliczka Mine ended in July 1996.

The rock salt resources and output in Poland in 1989–2004 are presented in Fig 42.1.

The exports amounted in 2004 to 486.9 thousand tons of industrial rock salt, alimentary salt and brine, and to 958.9 thousand tons of sodium compounds. In the same time a total of 294.5 thousand tons of industrial salt, food salt and brine were bought abroad. Imports of sodium compounds amounted to 135.5 thousand tons.

Magnitude, value and main directions of export are presented in Table 42.2 and import in Table 42.3.

Fig. 42.1 Rock salt resources and output in Poland in 1989-2004

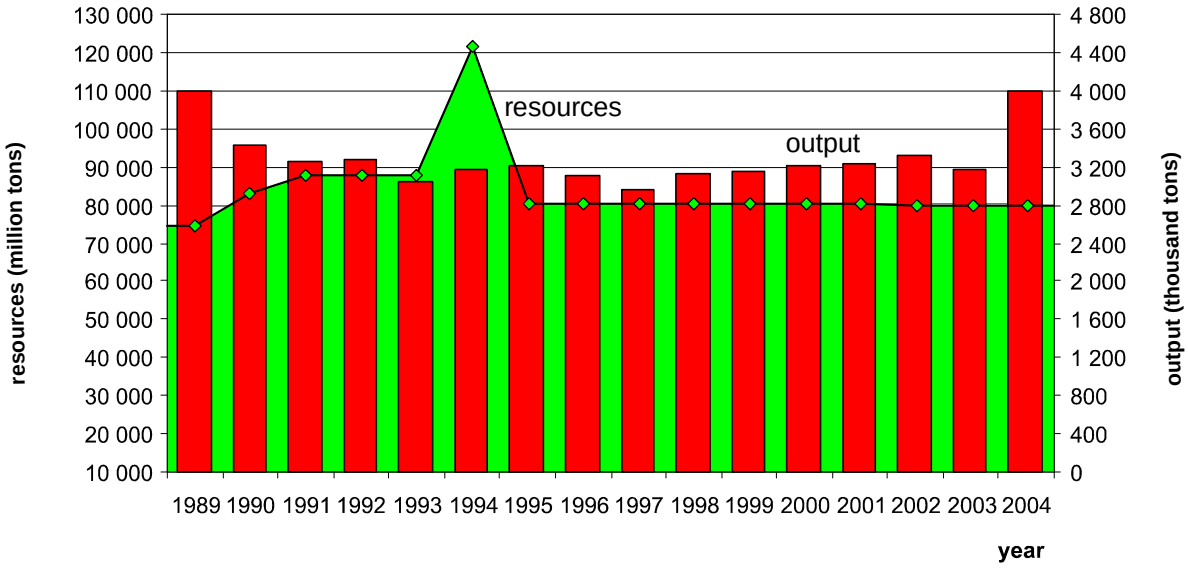


Table 42.2 Directions of Polish export of halite and sodium compounds

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Halite							
	Total	486.91	91,015				
1	Czech Rep.	327.31	47,304	6	Finland	8.38	1,732
2	Germany	113.26	27,563	7	Sweden	5.11	1,568
3	Belgium	10.29	4,306	8	Hungary	3.58	1,168
4	Slovakia	8.70	2,113	9	Netherlands	0.75	737
5	France	4.86	1,919	10	Lithuania	1.09	467
Sodium compounds							
	Total	958.91	559,369				
1	Czech Rep.	194.91	123,842	23	Austria	7.07	3,225
2	Germany	124.48	67,754	24	Columbia	3.88	3,222
3	Sweden	119.54	55,172	25	Estonia	6.13	2,982
4	Finland	72.76	36,090	26	Belarus	3.75	2,973
5	France	68.39	29,997	27	China	3.58	2,694
6	United Kingdom	61.99	28,686	28	Chile	3.12	2,281
7	Netherlands	38.25	21,814	29	Spain	1.26	2,119
8	Hungary	32.13	18,800	30	Venezuela	2.93	2,033
9	Turkey	6.98	16,128	31	Malaysia	2.29	1,730
10	Denmark	27.97	15,706	32	Hong Kong	2.17	1,616
11	Norway	30.22	15,117	33	Algeria	2.23	1,530
12	Belgium	21.39	14,442	34	Morocco	2.68	1,333
13	Russia	29.30	12,027	35	Latvia	2.54	1,086
14	Croatia	6.33	11,881	36	Senegal	1.25	951
15	Ukraine	9.01	8,999	37	Argentina	1.25	934
16	Slovakia	15.47	8,395	38	Israel	1.35	857
17	Romania	4.49	8,106	39	Canada	0.35	837
18	Italy	11.40	7,853	40	Uruguay	1.60	799
19	Lithuania	8.80	4,938	41	Niger	1.22	779
20	Brazil	4.27	4,611	42	Guatemala	1.01	743
21	Ecuador	5.18	3,784	43	Panama	0.77	534
22	Peru	4.50	3,376	44	Mexico	0.64	452

Table 42.3 Directions of Polish imports of halite and sodium compounds

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Halite							
	Total	**294.52**	**30,595**				
1	Ukraine	149.80	11,308	4	France	0.16	697
2	Belarus	117.00	9,715	5	Italy	0.15	521
3	Germany	25.97	6,949	6	Slovakia	0.26	392

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Sodium compounds							
	Total	**135.47**	**125,674**				
1	Germany	20.70	19,921	11	Kazakhstan	1.50	3,722
2	Sweden	9.16	18,960	12	Belgium	1.33	3,482
3	Spain	31.00	15,700	13	Italy	1.50	2,975
4	Austria	20.50	11,230	14	Netherlands	1.57	2,698
5	Turkey	6.53	8,684	15	Hungary	0.85	1,738
6	USA	5.32	8,167	16	China	0.70	1,508
7	Russia	5.49	5,586	17	Finland	0.62	1,242
8	Czech Rep.	10.86	5,510	18	Denmark	2.27	1,078
9	France	2.49	5,446	19	United Kingdom	0.32	894
10	Ukraine	10.69	4,772	20	Israel	0.21	603

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

43. 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 and from the deposit of foundry sand near Opoczno as well as the natural aggregates in Opole voivodeship.

The sands and gravels for filtration recovered in 2004 amounted to 62 thousand tons, including:

* those obtained from the glass sands – 12,013 tons gravel for filtration;
* those obtained from the foundry sand – 37,596 tons of the quartz gravel and
* those obtained from natural aggregates – 12,719 tons of the sands and gravels used for filtration.

44. SILICEOUS EARTH

Explored deposits of siliceous rock (decalcified gaizes) occur in tectonic troughs on the surrounding of the Holy Cross Mountains and in lob forms covered by Oligocene sediments in the Lublin Upland (Plate 4). Siliceous earth is used, after refinement, among others in 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 of thickness exceeding 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 intrinsically economic resources of four deposits of siliceous earth amount to 2.2 million tons, and almost half of them are explored in detail. Since 1991 only one very little deposit of siliceous earth is being exploited periodically, with output of several dozens tons.

The magnitude of intrinsically economic resources of siliceous rock, and the state of their identification and management are presented in Table 44.1.

Table 44.1 Siliceous earth (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		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 in 2004 to 6.4 thousand tons. In the same time 0.5 thousand tons of these materials were exported. The above-mentioned materials were imported mainly from the Western Europe (Denmark, 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 diatomaceous earth is presented in Table 44.2.

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 surrounding of the Holy Cross Mountains and in the Lublin Upland.

Table 44.2 Directions of Polish imports and exports of diatomites, siliceous and diatomaceous earth

Import				**Export**			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**6.37**	**9,937**		**Total**	**0.54**	**1,410**
1	USA	4.50	7,045	1	Denmark	0.10	698
2	Denmark	1.02	1,293	2	Lithuania	0.32	332
3	Germany	0.24	474	3	Ukraine	0.03	202

45. SILVER

In Poland, silver does not form individual deposits but coexists with copper ores of the Zechstein formation in the Lower Silesia (Table 45.1). Only a small quantity of silver coexists with lead and zinc in Zn-Pb ores in the Silesia-Cracow region.

The total resources of silver in Poland are estimated at over 113 thousand tons, of which only 4.1 thousand tons is connected with Zn-Pb ores. The quantity of silver in ores, extracted in 2004, amounted to 1,552 tons (Fig. 45.1) and 1,334.2 tons of silver was extracted from the ores.

Over 91 % of the silver is exported (Table 45.2).

Table 45.1 Silver (in thousand tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**15**	**109.30**	**104.88**	**4.42**	**55.69**	**43.46**
including reserves of exploited deposits						
Total	5	69.03	69.03	–	1.65	43.46
including resources of not exploited deposits						
Total	7	37.19	34.38	2.82	52.74	–
Exploration	4	23.79	23.79	–	–	–
Prospecting	3	13.41	10.59	2.82	52.74	–
including abandoned deposits						
Total	3	3.08	1.47	1.60	1.30	–

Fig. 45.1 Silver resources and mine production in Poland in 1989-2004

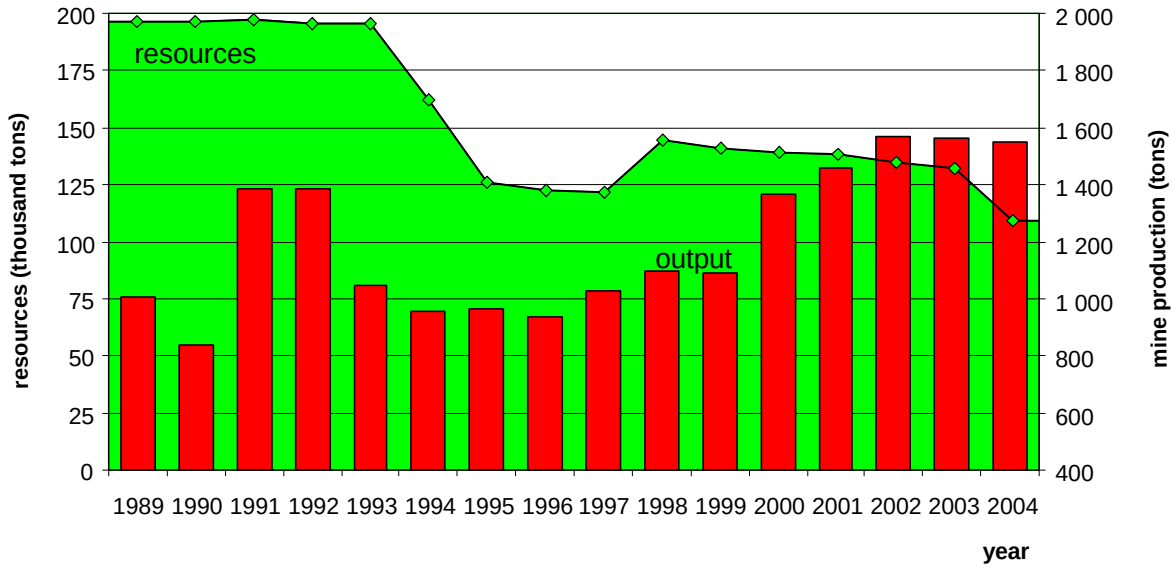


Table 45.2 Directions of Polish imports and exports of silver

Import				Export			
No	Country	Tons	Thousand PLN	No	Country	Tons	Thousand PLN
	Total	**66.01**	**6,850**		**Total**	**680.44**	**983,294**
1	Germany	15.22	2,672	1	United Kingdom	240.15	360,887
2	France	3.12	1,605	2	Germany	80.69	180,331
3	United Kingdom	30.00	1,342	3	Belgium	0.00	162,011
4	Czech Rep.	3.59	443	4	USA	180.00	146,538
5	Belgium	0.05	291	5	Thailand	140.01	108,019
6	Netherlands	0.21	225	6	Switzerland	25.05	19,606
7	Italy	13.24	211	7	Czech Rep.	9.27	3,605
8	Sweden	0.00	13	8	Slovenia	1.69	1,247

46. SULFUR

The deposits of sulfur occur in the northern part of the Carpathian Foredeep, in Torton rocks, mainly in gypsum-origin limestone (Plate 4). Sulfur fills small caverns and chaps, and its content in the rock can reach 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 2004 only one deposit of native sulfur was exploited by production wells. In three deposits of natural gas sulfur was exploited as accompanying raw material.

The magnitude of the sulfur resources and their state of identification and management are presented in Table 46.1.

The resources of native sulfur deposits in the Carpathian Foredeep increased continuously from their discovery in 1953 till 1976. This was the result of intensive identification works that brought new promising discoveries. The most dynamic increase of resources was noted in the years 1965–1976. The resources in 1976 exceeded 1 billion tons. In the next years a gradual decrease of the resources had been noted caused due to exploitation of the deposits and recently also to the unfavourable situation on international markets. In view of this the resources of deposits in inferior exploitation conditions or of deposits largely exhausted were neglected in the balance. At present the resources of native sulfur amount to 468.5 million tons. The resources and output of sulphur in 1989–2004 are shown in Figure 46.1.

The sulfur output increased as dynamically as the resources and reached in 1980 over 5 million tons and maintained that level in the next years. At the beginning of the nineties regression began due to the lowering of prices of sulfur on international markets where cheaper sulfur from desulfurization of bituminous raw materials appeared. The output of sulfur in Poland in 2004 was 781.9 thousand tons, including 21.3 thousand tons of sulfur from desulfurisation of natural gas.

In 2004 exports of sulfur (Table 46.2) amounted to 560 thousand tons. Exports of sulfuric acid and sulfur compounds amounted 161.75 thousand tons. In 2004 imports of sulfur compounds and sulfuric acid amounted to 7.6 thousand tons (Table 46.3).

The magnitude, value and main directions of exports and imports of sulfur acid and sulfur compounds are presented in Table 46.3.

Reconnaissance resources amount to 32 million tons of sulfur and are related to occurrence of copper, zinc and lead sulphide ores.

Table 46.1 Sulfur (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**17**	**468.47**	**412.05**	**56.42**	**29.77**	**33.83**
including reserves of exploited deposits						
Total	5	38.05	38.04	0.01	0.55	33.83
including resources of not exploited deposits						
Total	6	198.33	142.80	55.53	8.77	–
Exploration	3	100.57	100.57	–	0.01	–
Prospecting	3	97.76	42.23	55.53	8.76	–
including abandoned deposits						
Total	6	232.10	231.21	0.89	20.46	–

Fig. 46.1 Sulfur resources and output in Poland in 1989-2004

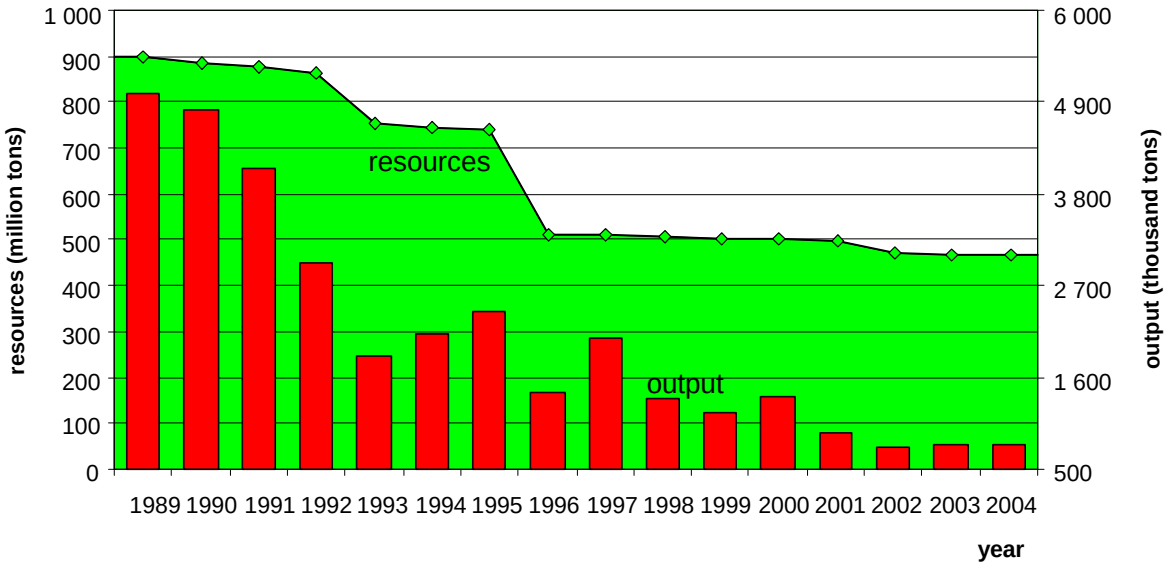


Table 46.2 Directions of Polish export of crude sulfur and refined sulfur

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Crude sulfur							
	Total	522.85	87,658				
1	Morocco	483.10	79,188	3	Senegal	24.26	3,917
2	Czech Rep.	13.59	3,943	4	Sweden	1.47	355

No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
Refined sulfur							
	Total	37,22	16,389				
1	Czech Rep.	11,27	2,970	7	Romania	0,32	889
2	Germany	7,50	2,380	8	Slovenia	2,16	835
3	Hungary	1,47	1,861	9	France	1,12	746
4	Russia	0,36	1,091	10	United Kingdom	1,22	743
5	Austria	3,21	1,017	11	Belgium	0,89	549
6	Sweden	3,86	905	12	Bulgaria	0,84	349

Table 46.3 Directions of Polish imports and exports of sulfuric acid and sulfur compounds

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**7.64**	**13,053**		**Total**	**161.75**	**13,740**
1	Germany	2.79	4,367	1	Slovakia	48.70	4,644
2	China	0.71	1,997	2	Brazil	46.48	4,261
3	Czech Rep.	2.56	1,132	3	Czech Rep.	35.86	2,551
4	Italy	0.22	1,059	4	Austria	15.75	516
5	Austria	0.13	856	5	Norway	6.00	514
6	India	0.59	715	6	Germany	6.01	257
7	United Kingdom	0.03	584	7	Lithuania	0.09	183
8	South Africa	0.14	559	8	Russia	0.05	182

47. TIN

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

The resources of the deposits, which were estimated at about 2.9 million tons of ore with an average tin contents of about 0.48 % Sn (e.i. about 22.6 thousand tons), were classified as potentially economic.

The entire Polish demand for tin is satisfied by imports that amounted to 2.05 thousand tons in 2004 (Table 47.1).

Table 47.1 Directions of Polish imports and exports of tin

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**2.051**	**49,890**		**Total**	**0.771**	**2,324**
1	Belgium	0.637	8,802	1	Belgium	0.705	951
2	Malaysia	0.211	7,478	2	Ukraine	0.016	559
3	Vietnam	0.201	5,781	3	Germany	0.021	364
4	Indonesia	0.142	4,623	4	Russia	0.004	140
5	China	0.127	4,071	5	Slovakia	0.004	110
6	Russia	0.134	3,752	6	France	0.017	81
7	United Kingdom	0.099	3,041	7	Lithuania	0.002	59

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
8	Thailand	0.072	2,414	8	Belarus	0.001	16
9	Germany	0.058	2,371	9	Estonia	0.000	16
10	France	0.036	1,312	10	USA	0.000	10
11	Peru	0.040	1,185	11	Malaysia	0.000	5
12	Spain	0.035	973	12	Romania	0.000	5
13	Netherlands	0.077	846	13	Japan	0.000	3
14	United Arab Emirates	0.059	747	14	Iran	0.000	2
15	Ecuador	0.025	585	15	Jordan	0.000	1
16	Italy	0.032	576	16	Latvia	0.000	1
17	USA	0.038	556				

48. TITANIUM

The titanium resources are estimated at 97.7 million tons, with an average TiO_2 content of 7.3 % found in the titanium-magnetite deposits in the Suwałki massif, in the north - eastern Poland (the Krzemianka and Udryń deposits). The exploitation of these deposits does not seem possible in the future because of the big depth and some problems with environmental protection in this region.

The entire country's demand is met by imports, mainly of titanium ores and their concentrates. Imports amounted to 128 thousand tons and exports (of titanium compounds) to 21 thousand tons in 2004 (Table 48.1).

Table 48.1 Directions of Polish imports and exports of titanium

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**127.95**	**314,754**		**Total**	**20.86**	**144,235**
1	United Kingdom	8.42	74,671	1	Italy	3.46	22,993
2	Germany	5.88	51,544	2	France	3.26	21,196
3	Norway	80.24	36,037	3	Germany	2.49	18,380
4	Netherlands	4.00	34,299	4	Sweden	2.14	15,103
5	Belgium	2.85	24,218	5	Finland	1.56	11,069
6	Canada	16.04	23,009	6	Belgium	1.27	8,594
7	France	1.66	11,657	7	Spain	0.99	6,811
8	Czech Rep.	1.74	10,721	8	Netherlands	0.92	6,579
9	USA	0.69	8,992	9	Denmark	0.82	5,798
10	Ukraine	2.43	7,093	10	Turkey	0.76	5,612
11	Spain	0.91	6,841	11	United Kingdom	0.63	4,355
12	Saudi Arabia	0.70	6,131	12	USA	0.56	3,794
13	Finland	0.64	5,718	13	Serbia & Montenegro	0.44	3,083
14	Italy	0.47	3,752	14	Thailand	0.28	2,028
15	China	0.61	2,899	15	Switzerland	0.21	1,601
16	Slovenia	0.29	2,379	16	Hungary	0.30	1,462
17	Austria	0.14	1,233	17	Lebanon	0.16	1,134
18	Japan	0.02	1,187	18	Ukraine	0.13	1,061
19	Mexico	0.06	498	19	Portugal	0.12	860
20	Greece	0.07	490	20	Belarus	0.06	530
21	Hungary	0.01	347	21	Latvia	0.06	520

49. 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 northeastern Poland.

The resources of vanadium accompanying copper ores amount to about 143 thousand tons. This element is not extracted in the course of processing the copper ore.

In the Suwałki titanium-magnetite deposits average vanadium content amounted to less than 0.3 %. The low contents of this metal, big depth of the deposit and environmental protection problems make the exploitation not possible in the future.

50. 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.

The state of the intrinsically economic resources of the vein quartz deposits is presented in Table 50.1.

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.

Table 50.1 Vein quartz (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**7**	**6.59**	**4.48**	**2.11**	**0.35**	**3.25**
including reserves of exploited deposits						
Total	3	5.37	3.54	1.83	0.31	3.25
including resources of not exploited deposits						
Exploration	2	0.28	0.22	0.06	–	–
including abandoned deposits						
Total	2	0.94	0.72	0.22	0.05	–

51. ZINC AND LEAD ORES

Zinc and lead ores in the Silesia-Cracow region, which constitutes the northern and north - eastern surrounding of the Upper Silesian Coal Basin (Plate 3), are of industrial importance. The strata bound type deposits are connected 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 Palaeozoic 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.

In this region two types of ore occur: the sulphide ones and oxidized ores. To the country balance of raw materials in last fifteen years only sulphide ore was accounted, because of big hazard to the environment caused by the processing technology of zinc oxidized ores.

The zinc and lead ore resources and the state of their identification and management are shown in Table 51.1.

The intrinsically economic resources of zinc and lead ores amount to 174 million tons and are equivalent to 6.75 million tons of zinc and 3 million tons of lead. Over 20,1 % of ore resources occur in deposits in exploitation (35 million tons of the ore). In these deposits, 27.9 million tons of ores with a content of 1.17 million tons of zinc and 0.45 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 (Fig. 51.1), including 140–250 thousand tons of zinc (Fig. 51.2) and 40–90 thousand tons of lead (Fig. 51.2).

In 2004 the output amounted to 4,897 thousand tons yielding 173 thousand tons of zinc and 76 thousand tons of lead.

The domestic mining industry output of zinc and lead does not meet 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 51.2).

Table 51.1 Zinc and lead ores (million tons)

Specification	Number of deposits	Reserves/resources				Economic reserves
		I E R			Potentially economic	
		Total	Exploration	Prospecting		
Total resources	**21**	*** 174.06**	**94.12**	**79.94**	**148.87**	**27.89**
		***** 3.09***	***1.86***	***1.23***	***1.25***	***0.45***
		****** 6.75***	***4.17***	***2.58***	***3.68***	***1.17***
including reserves of exploited deposits						
Total	3	34.95	34.95	–	10.48	27.89
		0.54	*0.54*	–	*0.17*	*0.45*
		1.43	*1.43*	–	*0.33*	*1.17*
including resources of not exploited deposits						
Total	14	139.11	59.17	79.94	95.00	–
		2.56	*1.32*	*1.23*	*0.70*	–
		5.32	*2.74*	*2.58*	*1.87*	–
Exploration	6	63.70	59.17	4.53	27.27	–
		1.35	*1.32*	*0.03*	*0.26*	–
		2.86	*2.74*	*0.12*	*0.63*	–
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

In 2004, 162 million m^3 of mine water was removed from the zinc and lead mines and over 29 million m^3 were utilized. This is drinking and industrial water with low mineralization. In the same year, 2.7 million tons of wastes were generated, 0.47 million tons of which were utilized and the rest were dumped in settling ponds.

Fig. 51.1 Zinc and lead ores resources and output in Poland in 1989-2004

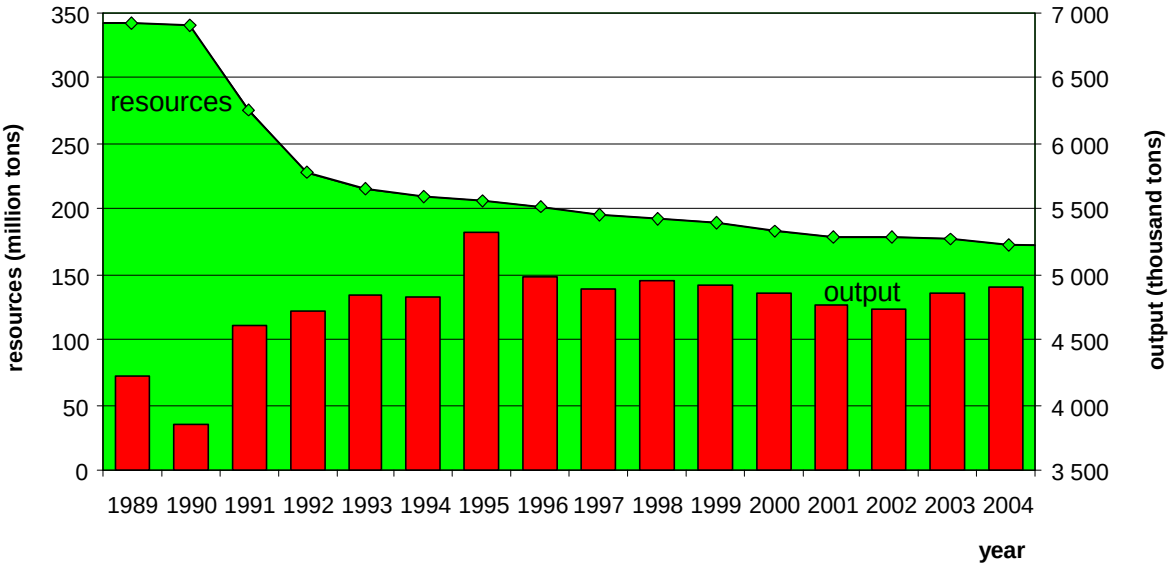


Fig. 51.2 Zinc and lead mine production in Poland in 1989-2004

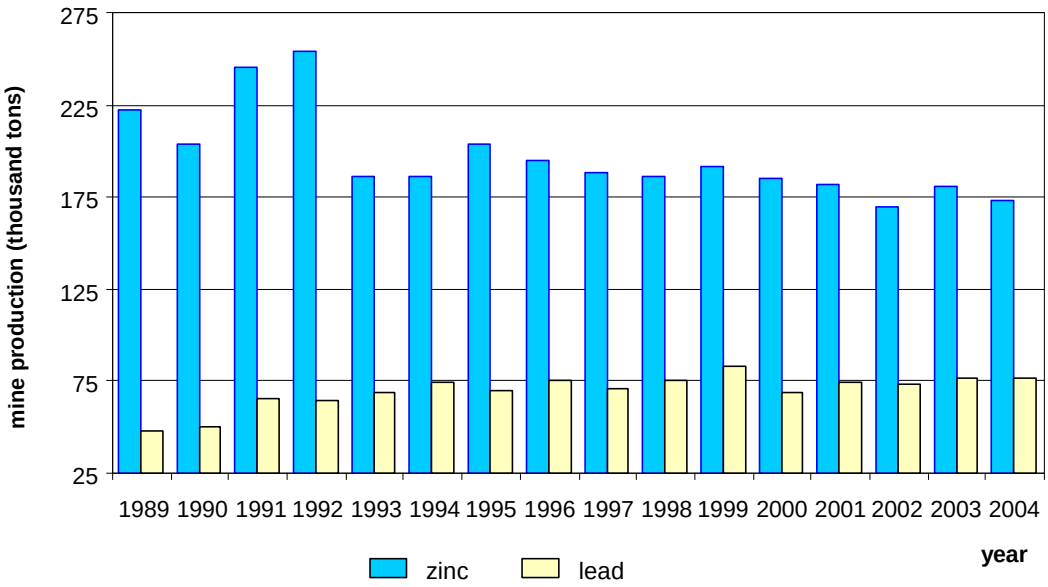


Table 51.2 Directions of Polish imports and exports of zinc

Import				Export			
No	Country	Thousand tons	Thousand PLN	No	Country	Thousand tons	Thousand PLN
	Total	**157.59**	**297,844**		**Total**	**132.97**	**384,107**
1	Belgium	14.11	65,232	1	Germany	36.05	111,176
2	Spain	11.03	42,108	2	Slovakia	20.58	68,331
3	Canada	33.10	38,020	3	Czech Rep.	16.48	64,174
4	Honduras	19.30	26,398	4	Hungary	6.86	28,786
5	Romania	21.57	24,682	5	France	6.14	23,182
6	Kazakhstan	3.84	15,232	6	Spain	12.00	16,955
7	Australia	13.81	14,093	7	Russia	10.90	15,018
8	Turkey	8.82	12,568	8	Bulgaria	9.10	11,449
9	Netherlands	4.51	9,866	9	Austria	2.49	9,251
10	Ireland	8.98	9,126	10	Italy	2.18	7,769
11	Germany	2.00	8,432	11	Luxemburg	1.76	7,188
12	Sweden	5.99	8,242	12	Ukraine	2.54	6,080
13	Finland	1.36	5,454	13	Belgium	2.62	3,496
14	France	3.53	4,101	14	United Kingdom	0.66	2,168
15	Hungary	1.23	3,216	15	Nepal	0.38	1,232
16	China	0.71	1,972	16	Finland	0.41	994
17	Slovakia	1.20	1,883	17	Slovenia	0.27	957
18	Czech Rep.	1.04	1,540	18	Switzerland	0.22	822
19	Ukraine	0.42	1,477	19	Lithuania	0.19	763
20	Nigeria	0.38	989	20	Sweden	0.17	720
21	Russia	0.19	790	21	Israel	0.19	643
22	Luxemburg	0.15	722	22	Croatia	0.15	634
23	Italy	0.08	483	23	Vietnam	0.12	505

52. THE ACCOMPANYING AND WASTE ROCK RAW MATERIALS

The accompanying rock raw materials have been discussed in the section of the present paper that 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. The users of deposits do not register these materials.

The total waste rock raw materials produced in 2004 amounted to 59.0 million tons, 14.8 million tons of which (25 %) were utilized.

53. 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 Combined Nomenclature (CN), which is deeply connected with the international classification system named Harmonized System - HS. Combined Nomenclature is the obligatory one in Polish Customs Tariff since 1991. The Combined Nomenclature is the part of the Integrated Tariff of the European Communities (TARIC) which was established by virtue of Article 2 of Council Regulation (EEC) No 2658/87 of 23 July 1987 on the tariff and statistical nomenclature and on the Common Customs Tariff. Regulation (EC) No 1789/2003 of 11 October 2003 amended the Regulation mentioned above. The Regulation established in 2003 is the obligatory one in Poland since the 1st of May 2004.

In 2004, 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 53.1.

Table 53.1 Mineral raw material imports and exports in 2004

Group of raw materials	Import Export				Balance	
	Quantity (thousand tons)	%	Value (PLN thousand)	%	Quantity (thousand tons)	Value (PLN thousand)
Total	**54,058** **39,745**	**100.0** **100.0**	**40,262,462** **25,407,673**	**100.0** **100.0**	**-14,313**	**-14,854,790**
Fuels	32,149 28,225	59.5 71.0	29,700,833 13,744,215	73.8 54.1	-3,924	-15,956,618
Metals	12,723 3,128	23.5 7.9	7,037,098 8,415,876	17.5 33.1	-9,595	1,378,777
Industrial minerals	9,186 8,391	17.0 21.2	3,524,532 3,247,582	8.8 12.8	-795	-276,950

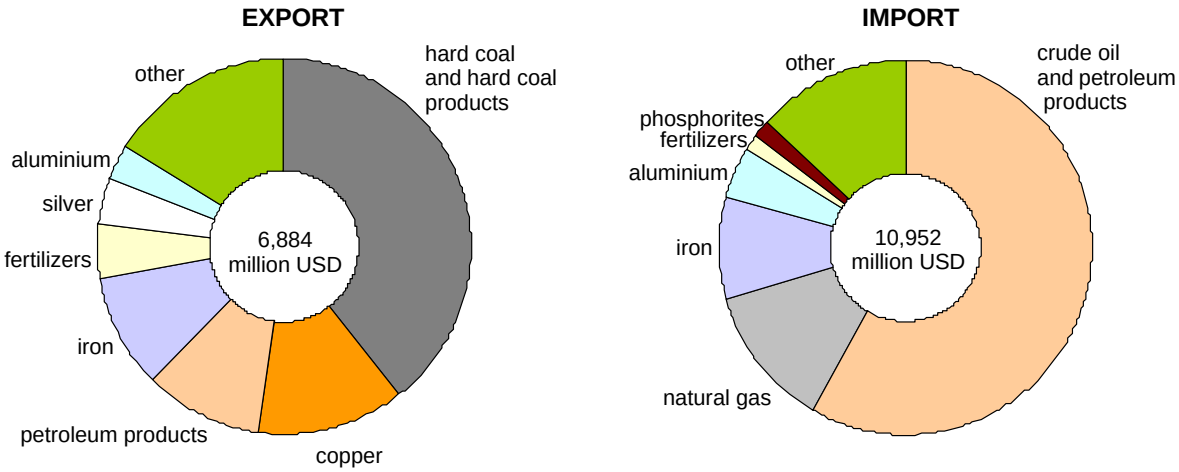
The total value of the raw materials exports amounted to PLN 25,408 million ($ 6,884 million) in 2004 and was by 76.3 % higher than in the preceding year. The imports value amounted to PLN 40,262 million ($ 10,952 million) and was almost 50 % (49.1 %) higher than those in 2003. The exports-imports turnover balance was still negative and amounted to PLN 14,855 million in 2004.

The highest values of imports, causing negative balance of the turnover value, related to such raw materials as crude oil (38.49 % of the total import value), petroleum products (19.66 %), natural gas (12.18 %), iron (9.09 %) and aluminium ores (4.46 %), nitrogen and multi-component fertilizers (1.45 %), phosphoric (1.3 %) and potassium (1.24 %) raw materials, dimension and crushed stones (1.11 %), insulating (0.45 %) and refractory materials (0.32 %).

The most important, as regards the value of the raw materials exports in 2004, were: hard coal and coal derivatives (39.39 % of the total import value), raw materials and products of copper metallurgy (12.65 %), petroleum products (10.48 %), iron and ferroalloys (9.67 %), nitrogen and multi-component fertilizers (4.63 %), silver (3.87 %), aluminium (3.23 %), salt and sodium compounds (2.56 %), insulating materials (1.51 %) and gypsum (1.14 %).

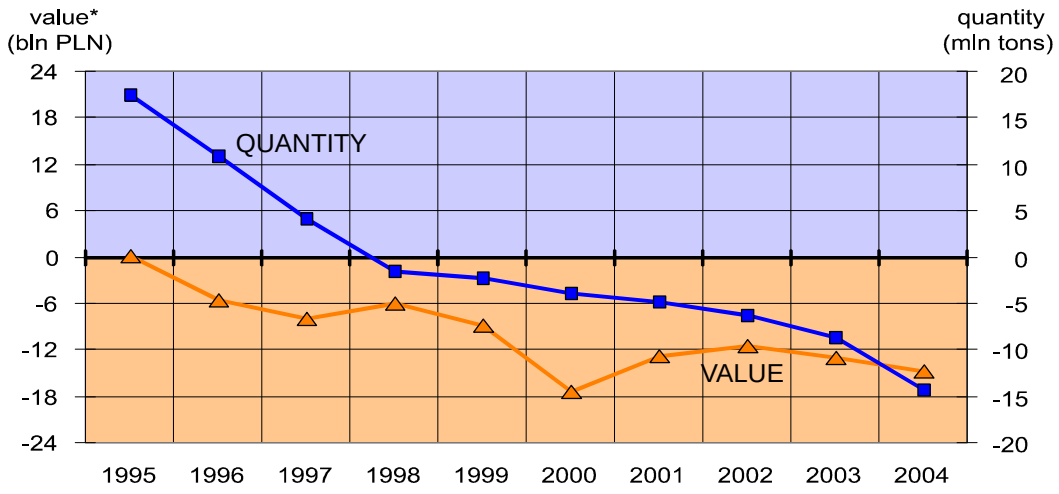
Figure 53.1 shows the structure of exports and imports in Poland, i.e. total values and shares of various groups of commodities in the international turnover.

Fig. 53.1 The structure of Polish raw materials export and import in 2004



The variation of the imports-exports balance by value and quantity for the last 10 years is shown in Figure 53.2. The quantity and the value balance have been declining during the analized period but the value balance has been oscilating especially between 1998 and 2001.

Fig. 53.2 Balance of Polish imports and exports in terms of value and quantity of mineral raw materials



* fixed prices as of 2004

The percentage contributions of the particular groups of raw materials to the value of exports and imports in 2000-2004 are presented in Figure 53.3 and Figure 53.4. The contributions to the export and import values have been oscillating in all mineral groups in last five years. The highest increase of the turnover value with respect to the previous year in the analysed period took place in 2004 in power raw materials exports. It was above 12 %. The contribution of this group increased for the first time in the last three years. Fuels are still the most important group in polish exports value mainly thanks to the hard coal export. The highest decrease of the turnover value (9.5 %) was also observed in fuels exports in 2002.

The contribution to the import values was stable within all mineral groups in the preceding period of time. The highest increase was noted in industrial minerals imports in 2002 (1.8 %). It should be emphasized that the contribution of metal raw materials has been increasing for last 3 years and amounted to 17.5 % in 2004.

Fig. 53.3 Contribution of mineral raw materials to the value of Polish exports in per cent in the years 2000-2004

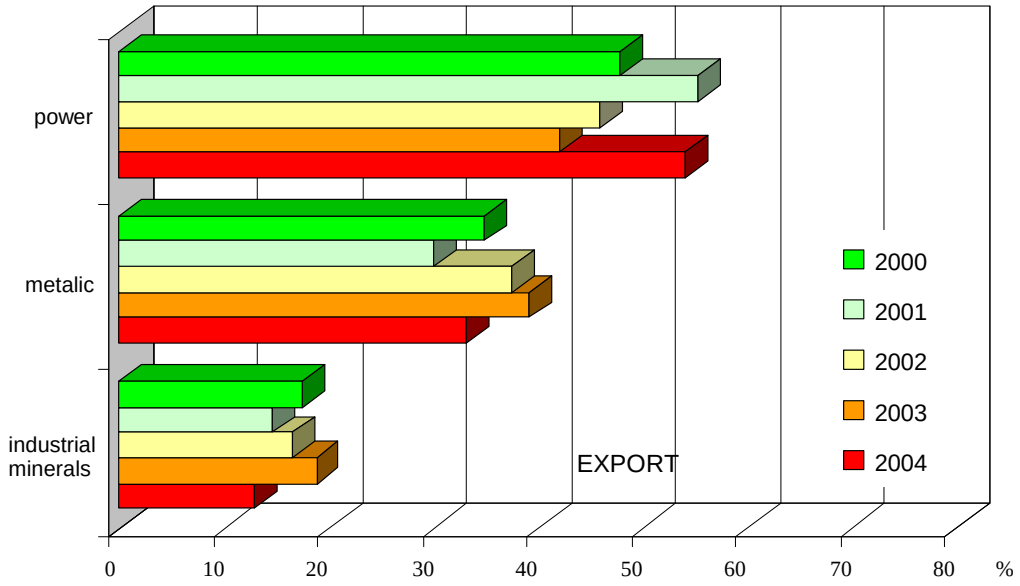
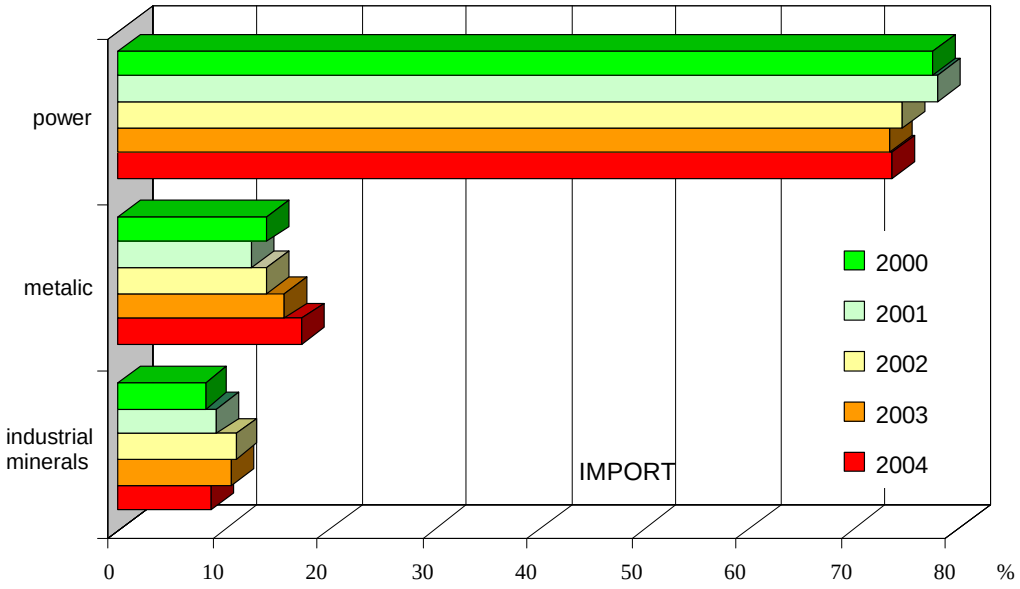


Fig. 53.4 Contribution of mineral raw materials to the value of Polish imports in per cent in the years 2000-2004



Regarding quantity of raw materials exports it can be seen that the fuels and industrial minerals exports have been changing in the preceding period of time. The fuels exports dropped in 2002 and 2003 but in the last year there was a significant growth (by 1.8 million tons). The industrial minerals exports decreased in 2001 and 2002 but have been increasing for last two years. Metal raw materials exports have been rising regularly in the preceding period of time (Fig. 53.5).

Fig. 53.5 Magnitude of mineral raw material exports in 2000-2004

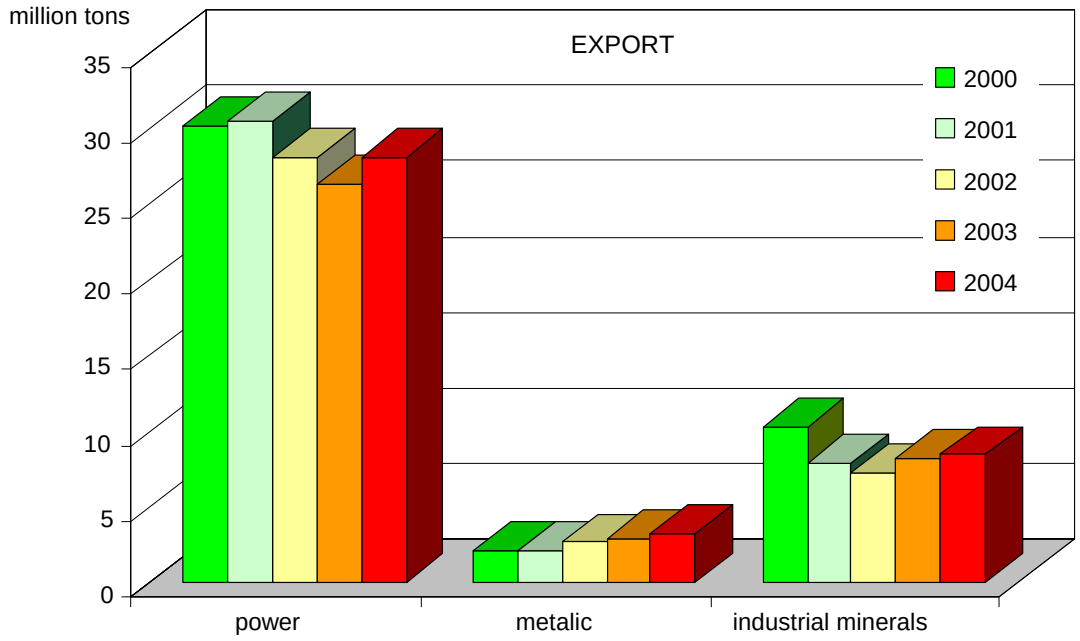
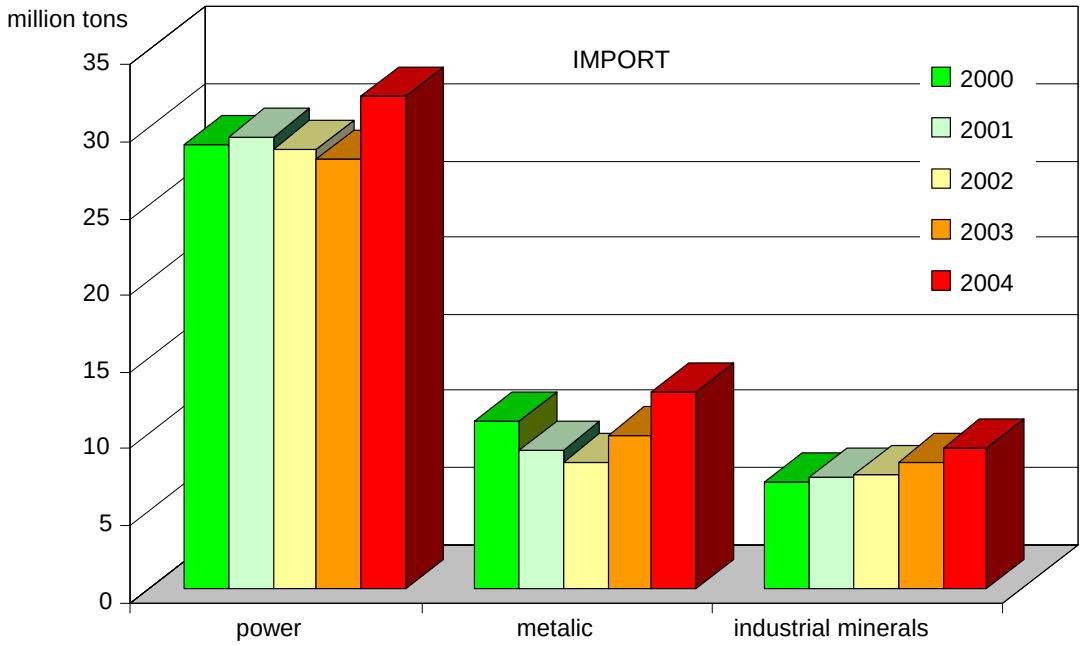
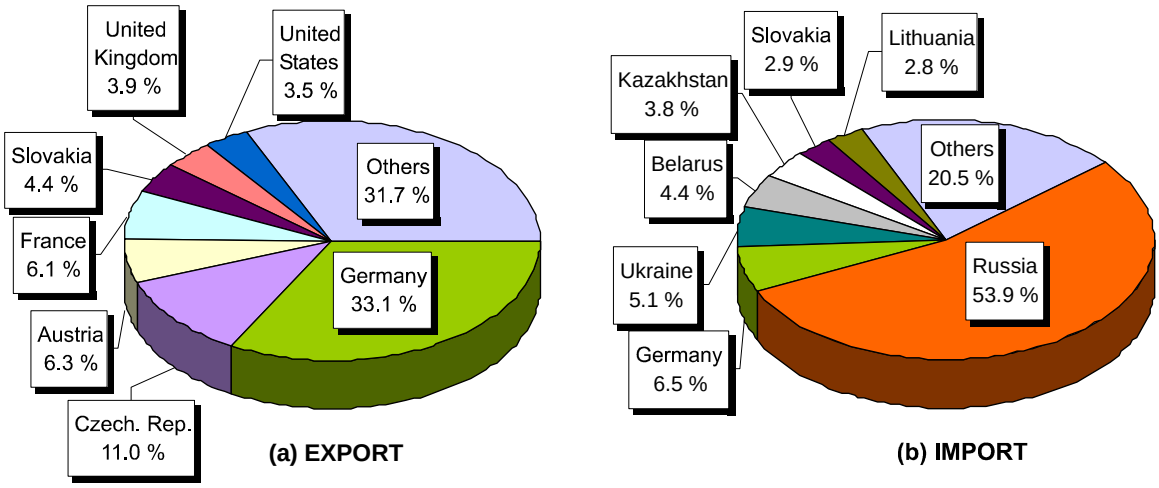


Fig.53.6 Magnitude of mineral raw material imports in 2000-2004



The fuels imports after four years of stability rose significantly in 2004 (by 4.1 million tons) and exceeded a 30-million tons level. The metal raw materials imports have been oscillating for five years, but there was a clearly growth in 2003 and 2004. The industrial minerals imports have been increasing during the whole analized period (Fig. 53.6).

Fig. 53.7 Polish exports (a) and imports (b) of raw materials in 2004, by countries



Regarding the exports, the highest was raw materials export to Germany. The export value to this country was PLN 8,404 million, which constituted 33.1 % of the total Polish raw materials exports value. Other country which contribution to the total Polish raw materials exports value exceeded 10 % was Czech Republic. Other important countries were Austria (6.3 %) and France (6.1 %) (Fig. 53.7 a).

The major part of the mineral raw materials imports in 2004 came from Russia. The import value was PLN 21,687 million, which constitutes 53.9 % of the total mineral raw materials imports value in Poland. Other important countries were Germany (6.5 %), Ukraine (5.1 %) and Belarus (4.4 %) (Fig. 53.7 b).

Definition of Mineability Assessment Stages

Mining Report

(Equivalent in Polish mining practice – **"Plan ruchu zakładu górniczego**" – "Mine operating plan" or "**Operat ewidencyjny zasobów"** – "Deposit reserves annual report")

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. The operator of the mine generally makes it. 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 summarizes 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 estimations 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 estimated resource quantities 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 Geological Study Stages

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 identify 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 known 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 utilized methods 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 that will be the target for further exploration. The estimations 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. The used methods 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 is 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 such closely spaced 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)

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

(Both terms are not used in Poland as yet)

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, with exctraction not justifying under the technological, economic, environmental and other relevant conditions, realistically assumed at the time of the determination, but possible in the future.

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. 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 too) the terms "reserve" and "resource" are covered by the one term "zasoby". For this reason the term "Total Resource" has been introduced.

Total Mineral Resource
(Ogólne zasoby bilansowe)

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 remaining part 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 estimation 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. Estimations of quantities are inferred, based on outcrop identification, geological mapping, indirect methods and limited sampling.

Reconnaissance Resource (**334**)
(D)

Based on Reconnaissance, having the objective to identify a deposit. Estimations of quantities should be made only when sufficient data are available and when the analogy with known deposits is possible.

POLAND - BASIC INFORMATION

After Concise Statistical Yearbook of Poland, 2004. CSO, Warsaw.

The total area of the country:	322,577 km^2
Length of the national border	3,505 km
with Russia	210 km
with Lithuania	104 km
with Belarus	418 km
with Ukraine	535 km
with Slovakia	541 km
with Czech Rep.	790 km
with Germany	467 km
Sea border	440 km
Population (in 2003)	38,191,000

The administrative division of Poland in 2003:
16 of voivodships,
379 of powiats,
2,478 of gminas.

Currency: zloty (PLN), exchange rate in the end of 2003 1 US dollars = 3,79 PLN

Gross domestic product (in 2002):
PLN 781,112.4 million

Foreign trade turnover (in 2003):

Imports	USD 68,003.9 million
Exports	USD 53,576.9 million

Commodity structure of imports and exports (in 2003) in percent, according to the Standard International trade Classification (SITC):

	Imports	Exports
Agricultural foodstuff goods:	4.9	7.9
Raw materials excluding fuels:	3.4	2.6
Fuels	9.1	4.3
Manufactured goods	44.6	47.3
Machinery and transport equipment	38.0	37.9

BIBLIOGRAPHY

BĄK B., PRZENIOSŁO S., 1993 – Perspective resources of raw materials in Poland (as of 31.XII.1990) (in Polish). PGI Warsaw.

DEPOWSKI S., KRÓLICKA J., SIECIARZ E., SIECIARZ K., 1993 – Evaluation of utilization of the Polish gas reserves. PGI Warsaw.

DEPOWSKI S., KRÓLICKA J., SIECIARZ E., SIECIARZ K., 1993 – Map of the crude oil and natural gas deposits in Poland 1:750 000. PGI Warsaw.

HOFFMAN M., PRZENIOSŁO S., 2004 – Barnówko–Mostno–Buszewo and Kościan Fields – National Case Study. UNECE Ad Hoc Group of Experts on Supply of Fossil Fuels. Geneva 10-11 November 2004.

JERZMAŃSKI J., 1993 – Feldspars (Feldspar and quartz-feldspar raw materials). In: Perspective resources of raw materials in Poland (as of 31.XII.1990) (in Polish). PGI Warsaw.

KOSMOWSKA-CERANOWICZ B., LECIEJEWICZ K., 1995 – Amber deposits in the south coast of Eocene sea. In: 2nd Seminary – Baltic amber, types and deposits in Poland. Gdańsk – Warszawa March 1995.

NIEĆ M., 1995 – Polish Approach to Resources/Reserves Classification. In: Proceedings ... Hannover.

NIEĆ M., PIWOCKI M., PRZENIOSŁO S., 2000 – Practical Application of the United Nations Framework Classification for Reserves/Resources. State of implementation in Poland, as of October 2000. UN ECE, ENERGY/2000/5/Add.10. Geneva.

OLKOWICZ-PAPROCKA I., 1995 – Amber deposit in Możdżanowo region near Słupsk. In: 2nd Seminary – Baltic amber, types and deposits in Poland. Gdańsk – Warszawa March 1995.

PIWOCKI M., 1993 – Lignite. In: Perspective resources of raw materials in Poland (as of 31.XII.1990) (in Polish). PGI Warsaw.

PIWOCKI M., 1995 – Amber occurrence in Chłapowo region. In: 2nd Seminary - Baltic amber, types and deposits in Poland. Gdańsk – Warszawa March 1995.

PIWOCKI M., PRZENIOSŁO S., 1997 – Propose of using a new international resources classification in Poland (in Polish). Geological Review, no 8. PGI Warsaw.

Proceedings of Workshop on Reassessment of Coal and Mineral Deposits under Market Economy Conditions. UN ECE, BGR, Hannover, 4-6 December 1995.

PRZENIOSŁO S., BĄK B., RADWANEK-BĄK B., SMAKOWSKI T., 1992 – Analysis of the zinc and lead ores management in Poland (state on the end of 1990). PGI Warsaw.

PRZENIOSŁO S. (ed.), 2005 – Annual Report of Mineral Reserves/Resources and Groundwater Resources as of 31.XII.2004 (in Polish). PGI Warsaw.

UN ECE, 2000 – Guidelines to the United Nations International Framework Classification for Reserves/Resources. Submitted by the UN-Task Force on Reserve/Resources for Solid Fuels and Mineral Commodities.

UN ECE, 1997 – UNITED NATIONS INTERNATIONAL FRAMEWORK CLASSIFICATION FOR RESERVES/ RESOURCES – Solid fuels and Mineral Commodities. ENERGY/WP.1/R.77, United Nations, Geneva.

WOJCIECHOWSKI A., 1993 – Gold. In: Perspective resources of raw materials in Poland (as of 31.XII.1990) (in Polish). PGI Warsaw.

Plate 1

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)
- Natural nitrogen gas fields (N N; 2 10 bln m³)
- Underground gas stores (0.2 2 bln 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 the 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 occurrence (after S. Depowski and others 1993)
- Boundary of Zechstein formation (after R. Wagner 1978)

Plate 2

HARD COAL AND LIGNITE DEPOSITS

Hard coal:

U S C B — Upper Silesian Coal Basin

Extent of deposits

L C B — Lublin Coal Basin

Deposits in exploitation

Not exploited deposits

Lignite:

Deposits in exploitation

Not exploited deposits

Occurrence of coal-bearing formations:

Paleogene lignite-bearing formations (after M. Piwocki)

Carboniferous hard coal-bearing formations

Areas without prospects for coal and lignite occurrences

Extent of coal-bearing Carboniferous formation

POLISH GEOLOGICAL INSTITUTE

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 3

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:

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

POLISH GEOLOGICAL INSTITUTE

0 50 100 km

- Voivodeship towns over
- Other towns
- State boundaries
- Rivers
- Reservoirs

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

Plate 4

CHEMICAL RAW MATERIAL DEPOSITS

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:

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

POLISH GEOLOGICAL INSTITUTE

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 5

BUILDING CERAMICS RAW MATERIAL DEPOSITS

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)
- Paleogene 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 the Sudetes and the Holy Cross Mountains (claystones and residual clays)

POLISH GEOLOGICAL INSTITUTE

0 50 100 km

State boundaries
Voivodeship boundaries
Rivers
Reservoirs
Voivodeship towns
Other towns

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

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
- Paleogene of the Carpathian Foredeep
- Carpathian flysch
- Cretaceous
- Jurassic
- Triassic
- Upper Paleozoic
- Paleozoic rocks of the Sudetes and the Holy Cross Mountains

POLISH GEOLOGICAL INSTITUTE

0 50 100 km

- Voivodeship towns
- Other towns
- State boundaries
- Voivodeship boundaries
- Rivers
- Reservoirs

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

Plate 7

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)
- Shales deposits (5 10 mln t)
- Deposits in exploitation
- Deposits not exploited

Areas of deposits occurrence:

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

POLISH GEOLOGICAL INSTITUTE

0 50 100 km

- Voivodeship towns
- Other towns
- State boundaries
- Voivodeship boundaries
- Rivers
- Reservoirs

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

Plate 8

CLASTIC ROCK RAW MATERIAL DEPOSITS

POLISH GEOLOGICAL INSTITUTE

0 50 100 km

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 Polish Glaciation and also fluvial and aeolian ones

Glacial and fluvioglacial accumulation of the Middle Polish 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 Polish Glaciation

Boundary of the Middle Polish Glaciation