Mineral resources of the Suwałki region*

This paper presents the resources of the most significant mineral deposits of the Suwałki region, NE Poland (Fig. 1). The deposits are described in a stratigraphic sequence, from the oldest Precambrian ones in the crystalline basement, to the youngest ones in the Quaternary formations. Ilmenite-magnetite ores from the region of Krzernanka, Udryn, Jeleniewo, and Jezioro Okrągłe in the Suwałki Massif are presented, as well as veiny ilmenite-sulphide nelsonites from the vicinity of Lopuchowo. Next, the occurrences of elements, mainly TR-bearing ones, from the Elk and Tajno Massifs are discussed. Water resources and different kinds of sands and gravels from Quaternary deposits of the Suwałki region complete this presentation.

INTRODUCTION

The region of Suwałki is rich in deposits of mineral resources. Many of them have been exploited continuously, e.g., water resources (surface and groundwaters) and rock resources. There are also untouched raw materials hidden deep in the ground making up the treasure of this land. The deposits of metals such as Fe, Ti, V, Cu, Ni, Co, Cr and REE, occur mainly in the crystalline basement and are related to the magmatic activity of the Precambrian.

Within Palaeozoic and Quaternary sequences, horizons of mineralized waters occur. Their resources and flows are variable, yet interesting as deposits. Rock deposits including natural boulders, gravels, clay ceramic raw materials, quartz sands, lacustrine chalk and gyttja belong to the Quaternary formation.

*The paper was presented during the scientific session on the 64th Meeting of the Polish Geological Society in the Suwałki district (9–12 September 1993).
PRECAMBRIAN DEPOSITS OF METAL ORES

The most spectacular deposits of the Suwałki region, which have provided controversy for years, are the ores of the iron-titanium-vanadium formation occurring within the anorthosite-norite Suwałki Massif (Fig. 2). They were found in small positive magnetic anomalies of Krzemianka, Udryn, Jeleniewo and Jezioro Okrągłe below 850 m (i.e., top of the crystalline basement) down to 2300 m J. Znosko (1962) — Fig. 3.

Magnetite ores are related to the Gothian activity stage of the sub-platform Mazurian complex chiefly built of Rapakivi-like granitoids and anorthosite massifs associated with them. The ores form lenses, nests, schlieren, veins and irregular bodies from several to over 100–200 m thick. The boundaries of the ores with the adjacent rocks are variable: sharp, rugged or wavy with anorthosites, straightline or gradually alternating with norites.

The ore consists of a mineral aggregate containing titanium and vanadium-bearing magnetite, ilmenite and hematite-ilmenite occurring in different ratios from 1:1 to 5:1 and even 10:1. Magnetite contains numerous products of disintegration of solid solutions such as: ulvöspinel, ilmenite, and aluminum spinels. There are the following accessory minerals: iron sulphides — pyrrhotite, pyrite, marcasite; copper sulphides — chalcopyrite, cubanite, chalcocite; and nickel and cobalt sulphides — pentlandite, bravoite, millerite, linneite, violarite and others. They make up 1–3% of the ores (S. Kebicki, J. Siemiątkowski, 1979; S. Speczik et al., 1988; A. Kozłowska, J. Wiszniewska, 1991). The iron content depending on the quality of ores ranges from 20 to 50% wt. The average chemical composition of the ores is as follows: 27% Fe, 7% TiO₂ and 0.3% V₂O₅.

The Krzemianka anomaly is located in the western part of the Suwałki Massif, close to its metamorphic cover (Fig. 3). The ore zone is arched, 1.5 km wide and 4–5 km long. The maximum south to north elongation of ore bodies reaches almost 1100 m and their width is 320 m. The ore series in Krzemianka is sometimes up to 750 m thick (Fig. 4). The deposit has been explored with over 70 boreholes of overall length 135,521 m. The ore resources documented by Warsaw Geological Enterprise are 726 mln t in the A+E+C₁ categories, and 350.6 mln t in the C₂ category (altogether 1076.6 mln t of economic ores) and 475.2 mln t
of subeconomic ore (A. Parecki et al., 1989; S. Przenioslo et al., 1993). Most Krzemianka ores occur at a depth interval of 1100–1700 m.

The Udryn deposit is located at the central part of the Suwałki intrusion, about 4 km east of the Krzemianka deposit. The area of the Udryn anomaly covers 4 km². Up to 1983, 12 boreholes were drilled in this region down to 2300 m. The overall area of the Udryn deposit is 773,000 m². Ilmenite-magnetite rocks containing over 15% Fe were reckoned as ores. The deposit dips 45°SW. The length of ore bodies forming lenses and veins reaches 3 km and their width is up to 0.6 km (Fig. 5). The Udryn deposit resources estimated by the Polish Geological Institute are 263.5 ml t of economic ores of 20% Fe content and 131.3 ml t of subeconomic ores of 15.0–19.9% Fe content (M. Subieta et al., 1985).

The deposits do not exhibit any significant differences in mineral composition, yet the Krzemianka ores are richer in parts containing spinel, whereas very little spinel occurs in Udryn. In addition, the rocks from the Udryn region are more faulted, resulting in division of the deposit into several blocks.

Similar mineralization has been found within the Jeleniewo and the Jezioro Okragle anomalies but very few boreholes have been drilled there.

At the Jeleniewo deposit, ores were encountered in the depth interval 1115–2300 m. Over the ore series rest leucogabbro-norites, and below are anorthosites. Ore bodies form lenses parallel to each other and elongated NW–SE, dipping SW. Ferrolites build 7–8% of the whole volume of the core. Inferred resources are estimated at about 116 ml t.

Fig. 2. Geological map of the Suwałki intrusion (after S. Kubicki and W. Ryka, 1982, modified)
K — Krzemianka deposit. U — Udryn deposit. 1 — anorthosites, 2 — norites, 3 — gabbro-norites and diorites, 4 — granitoids, 5 — granitogneisses, 6 — gneisses, 7 — boreholes

Mapa geologiczna intruzji suwalskiej (według S. Kubickiego i W. Ryki, 1982, zmodyfikowana)
K — złoże Krzemianka, U — złoże Udryn, 1 — anortozyty, 2 — nority, 3 — gabbro-nority i dioryty, 4 — granitoidy, 5 — granitogneisy, 6 — gneisy, 7 — otwory wiertnicze
The Jezioro Okragle anomaly is located in the NW part of the Suwalki intrusion. The ores from this region form lenses, streaks and irregular bodies up to 20 m thick. Anorthosites, anorthosites with magnetite and ilmenite schlieren as well as ferrolites were found in the
borehole profiles. The mineralization builds 3% of the core volume and is of an injective character. Extreme chromium content in ferrolites reaches 3400 ppm (J. Wiszniewska et al., 1989; K. Nejbert, J. Wiszniewska, 1994).
Mineral resources of the Suwalki region

It is assumed that the ores of the Suwalki Massif have a magmatic origin, yet the problem of their deposition is more complex and closely related to the genesis of anorthosites and accompanying rocks.

The Suwalki ores examined are a source of iron, titanium and valuable and demanded vanadium. They also contain Ni, Co and Cu which occur as sulphides associated with the ores.

In the Łopuchowo IG 1 borehole situated at the western, marginal zone of the Suwalki Massif, below the diorite and monzodiorite complex, vein, ore-bearing apatite rocks, not found previously, were encountered. Their thickness is from a dozen to several tens of centimetres. Their main minerals are: chlora-fluorapatite, magnetite, ilmenite, iron, cobalt, nickel and copper sulphides as well as biotite, chlorite, orthite and others. The rocks in
question contain high quantities of vanadium (up to 1% wt.), nickel and copper (0.3% wt.), chromium (0.2% wt.) and REE (up to 0.78% wt.) (L. Krzemieński et al., 1989).

Veiny rocks from Łopuchowo are similar to the rocks of a nelsonite type described from Nelson County in the state of Virginia, USA.
Table 1

Dissolved solids in groundwaters in the Suwalki region

<table>
<thead>
<tr>
<th>Aquifer</th>
<th>Depth [m]</th>
<th>Dissolved solids [g/dm³]</th>
<th>Production rate [m³/h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cretaceous</td>
<td>302-305</td>
<td>(Cl⁻) - Na⁺ 3 (vicinity of Goldap)</td>
<td>~</td>
</tr>
<tr>
<td>Upper Jurassic</td>
<td>400-500</td>
<td>Chlorine 6</td>
<td>0.5-2.0</td>
</tr>
<tr>
<td>Lower-Middle Jurassic</td>
<td>500-600</td>
<td>Chlorine 1 (vicinity of Augustów); 7 (vicinity of Goldap)</td>
<td>~</td>
</tr>
<tr>
<td>Triassic</td>
<td>600-800</td>
<td>Chlorine 40-116</td>
<td>several</td>
</tr>
<tr>
<td>Permian</td>
<td>960-1100</td>
<td>(Cl⁻) - (Br⁻) 110</td>
<td>1.8</td>
</tr>
<tr>
<td>Cambrian–Vendian</td>
<td>1600</td>
<td>Chlorine 120</td>
<td>~</td>
</tr>
</tbody>
</table>

To the platform stage of development, at the close of Precambrian, multistage intrusions of central type are related.

The Elk Massif covers about 400 km². It is circular in shape. This structure had formed in at least four stages, building ring-like intrusions of alkali granites and granodiorites, syenites, pulaskites, mariupolites and nephelinites (Fig. 6). Due to the overlapping magmatic processes in faulting zones, metasomatic and hydrothermal transformations took place, leading to the concentration of useful elements. Metal-bearing zones are from several centimetres to several metres thick. They exhibit a natural radiation anomaly of mixed uranium–thorium character. The niobite content is up to 0.86%, REE to 1.4% and zircon to 4.4%. Useful minerals form independent grains of pyrochlorite, perovskite-loparite, fluorocarbonate and others or occur as isomorphic admixtures (W. Ryka, 1994).

The other interesting object, for the occurrence of carbonatites with REE elements, is the volcano-plutonic Tajno structure covering about 10 km². Its top is at a depth of 600 m. The massif is built of ijolites, cut by younger veins of microsyenites and lamprophyres. Carbonatites are shaped in veiny and veiny-stockwork forms mostly concentrated in chimney breccia as well as in pyroxenite and syenite megabreccia (Fig. 7). Three stages of formation of the carbonatites have been distinguished — early, main and late within the temperature intervals 450-320, 320-180 and below 165°C, respectively. The main stage represented by carbonatites built of calcite, fluorite, burbankite with synchizite and parisite, strontianite, silicates and sulphides, is richest in rare earth elements. Burbankite containing more lanthanum than cerium is a main mineral carrying rare earth elements. In samples, the content of rare earth elements is up to 9% and within the spectrum of the REE elements, light lanthanides prevail (W. Ryka, 1992).
Groundwaters occurring within the whole complex of the sedimentary rocks as well as the crystalline basement are significant raw materials of the region. Sandy Cambrian and Vendian formations are an aquifer with chlorine waters of mineralization of 120 g/dm³. Unfortunately the depth of their occurrence makes their exploitation impossible. Permain, Triassic, Middle and Upper Jurassic, and Cretaceous formations contain horizons of mineralized waters of alternating production rate as well (Tab. 1).

Quaternary groundwaters are young and fresh and of an infiltration origin. They are separated from the mineralized waters by the waters of the transitional zone of mixed, chlorine-hydrocarbon composition. Groundwaters with potential exploitation (average flows over 10–30 m³/h) occur within the Quaternary formations exclusively (J. Mitrega et al., 1993).

QUATERNARY ROCK RAW MATERIALS

The last, but not least, type of mineral resources are rock raw materials occurring within Quaternary formations. In the Suwałki region, Quaternary sediments are from 112 to 281 m thick and represent all of the four glaciations. Most deposits are related with the Pleistocene activity of the glaciers and forms created due to their deglaciation.

The most significant mineral raw material of the Suwałki region is, at present, natural crushed rock. This material occurs in 13 documented deposits within the Suwałki –
Augustów outwash and in the Czarna Hańcza Valley within the first terrace above Wigry Lake. Several deposits have been documented near Olecko. The deposits from the Suwałki region are gravelly sand (average sand content 30–50%) or sandy gravel (50–75% sand). The documentation works have covered almost 3000 ha and the deposits contain over 680 mln t of crushed rock material. Mining is carried on at the Sobolewo A, Sobolewo B, Krzywólka – Suwałki and Potasznia I deposits. In the region of Olecko 5 deposits have been documented within the gravelly-boulder moraine (Fig. 8).

A characteristic feature of the deposits of natural crushed rocks is a high, sometimes exceeding norms, content of boulders. Pebbles 80–350 mm in diameter, making up so-called overgrain at the deposit, used for construction purposes, are of an industrial significance. Boulder and boulder-gravelly covers such as in the vicinity of Bachanowo, Hańcza, Kruszki occur over considerable areas in this region (P. Brański, E. Tolkanowicz, 1993).

Quartz sands used for calcareous-silicate bricks are important raw materials. Their deposits have been documented at the A+B+C1 categories in the region of Augustów – Zatartacze and Pisz. The economic resources are over 6 mln t but due to a limited demand and protection of the landscape are not exploited.

The Main Stadial of the North-Polish Glaciation (its Pomorze Stage) is related to the deposits of clayey raw materials for construction ceramics. They occur in western parts of the Suwałki region.

The economic resources documented in 13 deposits — Gordejki, Haraszyn, Ranty, Siedliska, Stóźne, Wronki Wlk., Zawiszyn, Pisanica, Kowale Oleckie, Guzy, Makosieje, Czynsze, and Pisanica — are about 7.5 mln m³ (S. Przeniosło, 1993). Unfortunately this is not a high quality material and only certain parts of the Stóźne and Gordejki deposits contain some better kinds (P. Brański, E. Tolkanowicz, 1993).

Worthwhile are also the occurrences of lacustrine chalk and gyttja formed during the Late Pleistocene and Holocene in stagnant water basins. It is estimated that near the village of Krużnik there are 36 mln m³ of them (E. Tolkanowicz, 1992).

The Suwałki region raw materials are the treasure of this land as well as the national wealth of Poland. Their proper, exploitation bearing in mind the natural beauty of the landscape of this region and its environment, plants and animals, is our duty too.

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Received: 1.07.1994

REFERENCES


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ZŁOŻA SUROWCÓW MINERALNYCH NA SUWALSCZYźNIE

Streszczenie

Obszar Suwalszczyzny jest bogaty w złoża surowców mineralnych. Wiele z nich znajduje się w ciągłej eksploatacji, jak surowce skalne czy zasoby wodne. Badania geofizyczne i geologiczno-poszukiwawcze prowadzone na masywie suwałskim w celu odkrycia rud metali użytkowych, zostały uwieńczone odkryciem w rejonie Krzemianki i Udrynia rud tytanowo-magnetycznych w prekambryjskich skałach anortozytów (L. Znoisko, 1962). Złoża powyższe zostały rozpoznane i udokumentowane w kategorii C₁ i C₂. Sumaryczne zasoby obu złóż wynoszą około 1,5 mld. tudy. Podobną mineralizację odkryto w rejonie anomali mineralnej Jeziora Okrągłego. W otworze wiertniczym Udrynia występują żwirowe skały apatytowo-kruszcowe, o podwyższonej zawartości pierwiastków ziemi węglowych (0,78%), wanadu (ponad 1%), niklu i miedzi (0,3%) i chromu (0,2%). Na południowy wschód od masywu suwałskiego znajduje się granitowo-syenitowy masyw elcki, obejmujący około 400 km², w którym występują metasomatyczne strefy metallocenońskie o podwyższonych zawartościach REE (1,4%), eurykenu (4,4%) i niobu (0,86%). W wulkan-plutonicznym masywie Tajna, o powierzchni 10 km², występują karbonaty z pierwiastkami ziem rudy, o zawartościach dochodzących do 9%. Głównym mineralą REE-odtynkowym jest baryt. Wody podziemne występują w całym kompleksie skał osadowych, jak i w masywie krystalicznym Suwałczyzny. Wody w utworach kambrowych, permu, triasu, jury i kredy są zmineralizowane: chlorkowe i chlorowosódowe, o zwartej zasobności i dopływach. W celu odkrycia rud metali użytkowych w rejonie anomali mineralnej Jeziora Okrągłego, w otworze wiertniczym Udrynia, występują żwirowe skały apatytowo-kruszcowe, o podwyższonej zawartości pierwiastków ziemi węglowych (0,78%), wanadu (ponad 1%), niklu i miedzi (0,3%) i chromu (0,2%).

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wodami słodkimi pochodzenia infiltracyjnego. Od wód zmineralizowanych oddziela je strefa przejściowa o składzie HCO₃–Cl–HCO₃.

Ostatnim typem surowców mineralnych są surowce skalne, występujące w utworach czwartordu o znaczej miąższości (112–281 m). Najważniejszymi surowcami skalnymi są kruszywa naturalne udokumentowane w 13 złożach w obrębie sandru suwalsko-augustowskiego, dolinie Czarnej Hańcza i regionie Ołecz. Inne surowce skalne to piaski kwarcowe do produkcji cegły wapiенно-piaskowej, popularnie zwanej silikatową (Augustów – Zatartaczce), złota surowców ilastych dla ceramiki budowlanej (Stołnice, Gordejki) oraz złota kredy jeziornej i gytli (Krusznik).

Nowa, proekologiczna wizja rozwoju Suwalszczyzny wymaga alternatywnego podejścia do planowanych inwestycji przemysłowych, wykorzystujących bogactwa naturalne tego regionu.