Minerals, Energy Resources, Soils and Waters in Kyustendil Region, South Europe

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DeepScience

Published, marketed, and distributed by:

Deep Science Publishing
USA | UK | India | Turkey
Reg. No. MH-33-0523625
www.deepscienceresearch.com
editor@deepscienceresearch.com
WhatsApp: +91 7977171947

ISBN: 978-93-49910-69-0

E-ISBN: 978-93-49910-27-0

https://doi.org/10.70593/978-93-49910-27-0

Citation: Vitov, O., & Sotirov, A. (2025). *Minerals, Energy Resources, Soils and Waters in Kyustendil Region, South Europe*. Deep Science Publishing. https://doi.org/10.70593/978-93-49910-27-0

Preface

This book offers a detailed study of Kyustendil region, located in geographical centre of Balkan Peninsula, South Europe. It has rich history in the extraction of gold, silver, copper, zinc, iron, tin, coal and mineral waters. Region is famous with the excellent soils for agricultural fruit growing. Data and considerations for the search for polymetallic, tin, mercury, tungsten-molybdenum, ores of rare and scattered elements and fluorite ores, as well as rock cladding and building materials, raw materials for ceramics and precious stones in the region of Kyustendil is presented in Part I with author Oleg Vitov. Data about soils, waters, coals and petroleum products is presented in Part I and Part II by Anton Sotirov.

Contents

Deep Science Publishing
https://doi.org/10.70593/978-93-49910-27-0

Minerals, Energy Resources, Soils and Waters in Kyustendil Region, South Europe

1 Introduction

Kyustendil region has a rich history in the extraction of gold, silver, copper, zinc, iron, tin, coal and mineral waters. Data and considerations for the search for polymetallic, tin, mercury, tungsten-molybdenum, ores of rare and scattered elements and fluorite ores, as well as coal, oil, rock cladding and building materials, raw materials for ceramics and precious stones in the region of Kyustendil are presented. The history of prospecting and extraction of ores and coal in the region is traced, indicating the benefits and harms of state administration in the process of assimilation of raw materials. It is found that Pautalia and Velbazhd were mining centres in antiquity and the Middle Ages with the management of resources by local authorities and structures. The Kyustendil region flourished in epochs of intensive mining and metallurgy. It is proposed that these processes and resources be effectively controlled and managed by a municipal development bank and a geological department of the municipality.

2 Status of the problem

Kyustendil Region (Fig. 1) is a mountainous region in the exact centre of the Balkan Peninsula in the western part of Bulgaria with a continental to Mediterranean climate and good water saturation. The main waterway is the Struma River, its main tributaries – the rivers Treklyanska, Dragovishtitsa, Bistritsa, Banshtitsa, Novoselska, Eleshnitsa, Dzherman, Rilska and the numerous smaller rivers and streams create extremely favorable conditions for agriculture and cattle breeding. The topography has a dissected mountain relief, flatlands, valleys and river valleys. The geological structure of the territory is complex and various ore minerals have been found in the river sands, which is a good prerequisite for the search for minerals (Zlatarski,1882).

Fig. 1. Location of Kyustendil region. Source: Own drawing

The geographical position and features have been evaluated since ancient times (Vitov, 2006) (Fig. 2) and Kyustendil was a commercial and administrative centre in the Roman Empire (Pautalia), medieval Bulgaria (Velbazhd), the Ottoman period and today (Kyustend'il means Konstantine's Land). The gathering of the borders between Bulgaria, Serbia and Macedonia in the Kyustendil region is a prerequisite for influence in transport, trade and cultural exchange. Kyustendil is a cultural centre in Bulgaria with good infrastructure and developed agriculture, cattle breeding and mining. The wonderful climate, mineral springs and beautiful nature are a gift used by man over the centuries. It is assumed that Kyustendil is a summer residence of emperors.

Modern changes in the state and the transition from a planned to a market economy (Article 19 of the Constitution) are destroying a large part of the infrastructure of the region. The trends are for depopulation and transformation of the Kyustendil region into an attractive site for tourism, balneotherapy, fruit growing and small business.

The studies carried out show that the Kyustendil region flourished in epochs of intensive ore mining and metallurgy. Kyustendil is a mining town – ancient Pautalia was built of stone fragments (boulders) – waste from gold mining on rivers and river terraces in antiquity (Dremsizova & Slokoska, 1978).

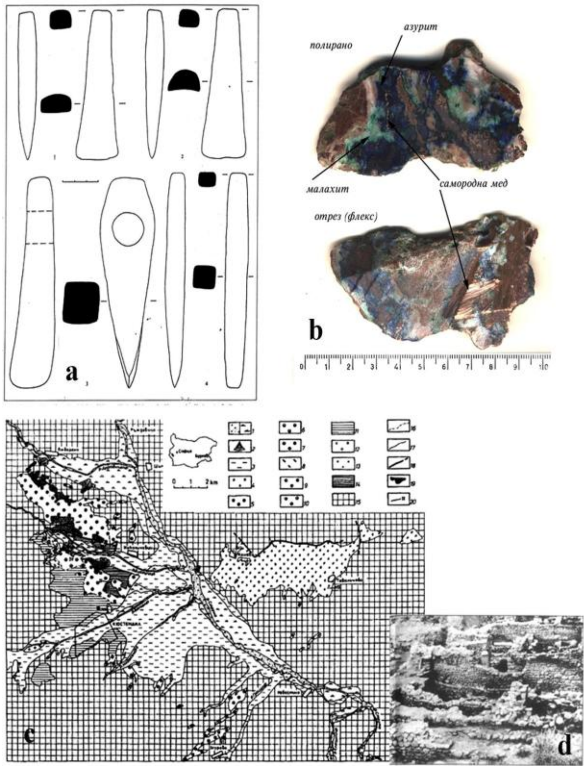


Fig. 2. A copper axe and wedges from the Slatino-Kyustendil region (a) are the earliest (Eneolithic) metal objects in Europe. They are made of native copper from Dragodan (b). In antiquity, mass quarrying of gold was carried out in old river terraces of the Struma River (c). The waste from the gold mining boulders (d) were used to build the city of Pautalia (Vitov, 2006).

Medieval Velbazhd had a government of 50 people, of which 15 were Saxons – miners and metallurgists (Lishev, 1969, Georgiev, 1987; Avdev, 2005, 2007; Vitov, 2010).

During the Ottoman period, the Sanjak of Kyustendil supplied the empire with 11 tons, and Bulgaria - 87 tons of gold (today Bulgaria's gold reserves are estimated at 32 tons of gold). During socialism, coal, inert materials, lead, zinc and pyrite ores were mined in the Kyustendil region.

The Kyustendil region is rich in artifacts and evidence of ore mining from ancient times. Archaeological excavations show that the native copper was known in the region and was used since the Eneolithic. The oldest metal European tools are made of native copper from the valley of the Struma River (Chohadziev, S., 1998).

Stone tools and ceramics in the region of Garbino testify to Dothrakian mining of gold and copper (Parvanov, Vatsev, Kraevski, 1969).

During the time of the Thracians and in antiquity, gold and silver were mined in the Kyustendil region (Denteletika region). In the Middle Ages, tin, gold, silver and iron were mined. During the Ottoman period, iron, silver and gold were mined. Modern data show that the Kyustendil region is rich in gold, coal, lead, zinc, copper, silver, iron ores, fluorite, rock cladding and building materials, healing mineral waters (Angelov, 1973; Dimitrov et al., 1995).

Thus, history teaches us that the destruction of the mining industry in the Kyustendil region is a mistake.

The subject of this work is an attempt to assess the current state of the problem and to identify ways to improve the situation (Vitov, 1992a). By necessity, the provided overview is incomplete and one-sidedly presents the opinions, views and knowledge of the authors and let it be taken as a discussion beginning in solving an important problem.

3 Literature review

Data on prospecting and mining of ores from 1878 to 1944

According to information from the State Gazette for Concession Rights and Extraction of Minerals in the Kyustendil Region13, it was established that the search for minerals (concession rights) after the Liberation from Ottoman Empire were given to Atanas Granitski (Granitsa village, coal); Angel Iliev, Alexi Georgiev, Vasil Stoilkov (Kamenishka Skakavitsa village, lead-zinc ores); Damyan Stoev (Zheravino, silver, lead and copper ores); Metodi Mavrudiev, Milan Korchev (Sovolyano village, coal); Anonymous company RUDA - Sofia (Polska Skakavitsa and Garbino villages, lead and other ores); Ivan Kozhuharov (Shishkovtsi village, coal); Dimitar Rizov (the village of Rasovo and the Lisets Mountain, lead, copper and other ores); Stefan Kasabov (Gyueshevo village, coal); Trifon Trifonov (Sazhdanik village, gold, silver, copper and other ores); Nikola Popov (the villages of Prekolnitsa and the village of Rasovo, silver, lead, copper and other ores); Ivan Karadzhov (Gyueshevo village, lead, copper and other ores); Lyuba Hristova (Vratsa village, lead, copper and other ores); Yosif Simeonov (Garbino village, asbestos); Dr. Asen Keremedchiev (Prekolnitsa village, Razhdavitsa village, Garbino village, copper ores); Simeon Maksimov (Gorno Uyno village, silver, gold, copper, platinum, tin, lead-zinc and mercury ores); Elena Antonova (Stensko village, Polska Skakavitsa village, Razhdavitsa, Garbino, iron ores and asbestos); Hristo Angelov (Gorno Uyno village, copper ores); Milchanitsa Society (Granitsa village, oil workers); Cornelis Bronk from the Netherlands (Tavalichevo village, Katrishte village, petrol). Mining of minerals during this period was carried out in the villages of Sovolyano, the village of Nikolichevtsi and the Bistritsa mine (coal), as well as the extraction of clay for the ceramic factory near the village of Bagrentsi. There is a project for the construction of a small thermal power plant - heating and electricity for the town of Kyustendil with coal from Nikolichevtsi.

The Central State Archives – Sofia keeps documentation for the origin, operation and liquidation of “Manganite” Ltd. for exploration and exploitation of manganese deposits in the land of the villages of Dobri dol and Gabreshevtsi – Kyustendil region.

Political struggles and numerous wars (Balkan, Inter-Allied, First and Second World Wars) have prevented the absorption of concessions.

From 1935 to 1941, after negotiations between Germany and Bulgaria, a team of 1500 young German specialists carried out a study of Bulgaria with a topographic map in M1:25000 and geological surveys. In the region of Kyustendil, optical calcite in the area of Dvorishte (Konyavska Mountain), tungsten-molybdenum ores in the area of Dolarska Mahala (Lisets Mountain), oil and coal in the region of Smolicano were searched for and probably mined (according to the memories of local people). From that time there are galleries for graphite mining in the Treklyano region and copper ores in the Dragodan region. This information should be clarified and other traces of the activities of the Germans should be found in their, but also in the Russian, American, and British archives. The National Geofund has only one report from the same time - for the Kremikovtsi field.

4 Methods and materials

A mineral deposit is a section of the earth's crust where, as a result of geological processes, a mineral substance has accumulated, which is suitable for industrial use in terms of quantity, quality and conditions (Smirnov, 1972). Well-studied objects of this kind are called "deposits" and are registered in the Balance of Minerals of the country. Understudied deposits or deposits with poor economic indicators are called "manifestations-appearing". Deposits without research are called "indications". The present paper uses the "Cadastre of Deposits, Manifestations and Indications of Minerals in Bulgaria in M1:100 000" of the National Geofund, prepared by Maznikov's group in 1997.

The main indicator for evaluating deposits is the price of the metal or mineral product, which price is formed on world exchanges and changes over time. To track these trends, data from the Internet was used (Fig. 3).

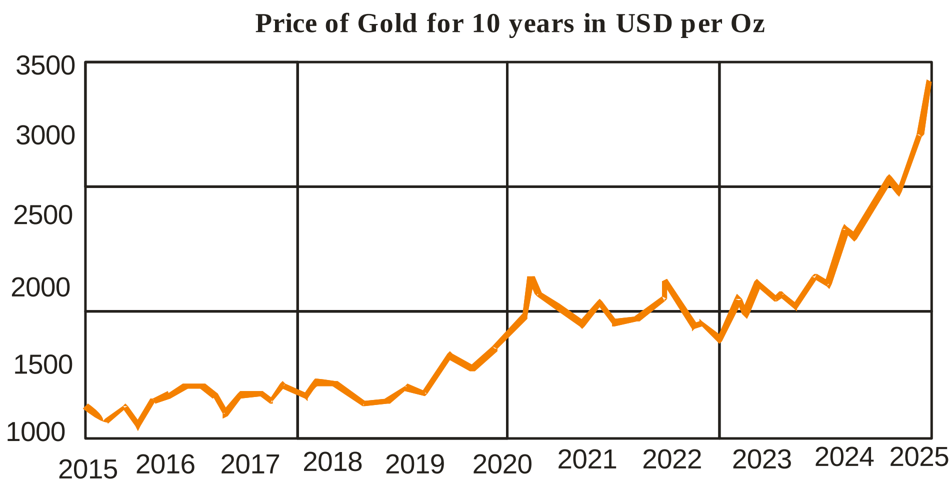


Fig. 3. Changes in exchange prices for gold, Source: data is used from https://goldprice.org/gold-price-history.html, Own drawing.

The prospect of searching for minerals is evaluated by studying the geochemistry of the soils, the mineralogy of the river sands (Ger. Schlich method), the combination of rock types and their changes, the presence of mineral and mineralized waters, the tectonics of the region, the presence of geophysical anomalies. The information from history (archaeology, written records, surveys) and toponymy are important (Kiryazova & Iliev, 1982; Yushkin, 1982; Vitov, 1999a,b, 2001).

River sands are a product of the decomposition of rocks and ores in the region (Fig. 4).

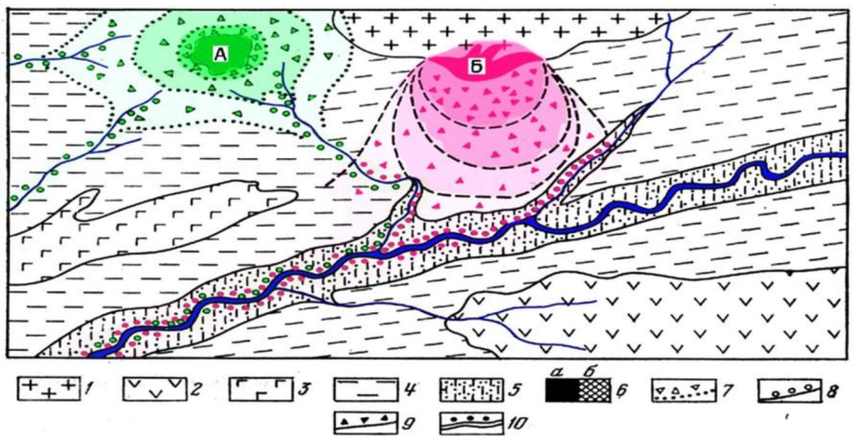


Fig. 4. Mechanical (minerals and ore chunks) and geochemical (atomic) halos and scattering fluxes: 1-granite; 2-porphyrite; 3-gabbro; 4-slate; 5-alluvium; 6-ore bodies of deposits A and B (a-vein; b-injection tools); 7-eluvial-deluvial halo of deposit A (concentric); 8-alluvial scatter flow of deposit A; 9-eluvial-deluvial scattering halo of deposit B (fan-shaped); 10-alluvial scatter flux of deposit B (Vitov, 1999a,b, 2001).

Sands are an element of soils and form fertility. Sands are a collector of groundwater and determine the quality of drinking water. Sands are a basic building material and determine the quality of people's homes - some of the minerals in the sands are radioactive or toxic. The distribution of ore minerals in the sands (schlich-mineralogical maps) points to the search for root sources - mineral deposits (Fig. 5) (Vitov & Sotirov, 2014; Vitov, 1992b, 1994a,b, 1995, 1997, 2005a,b).

In this work, schlich-mineralogical maps of the distribution of ore minerals in the region are presented according to data from schlich-mineralogical mapping (National Geofund). Soil geochemistry is studied by sampling the sub-humus horizon on a square or rectangular grid and emission spectral analysis of the samples (Fig. 6). The tests are for 32 or 24 chemical elements, after which they are drawn maps of the distribution of the content of the chemical elements or their combinations (Vitov&Yamakov, 1996; Vitov, 1999a,b, 2000).

Pronounced anomalies (maximum values) are checked by ditching and shallow drilling for the presence of tools. In case of insufficient data, poor sampling or poor quality analysis of the samples, deformations of the picture of distribution of chemical elements, minerals and mineral associations.

To eliminate these problems, data filtering is carried out with an appropriate methodology ("creeping window method" with data averaging, Fourier averaging, etc.). To study the regularities in the distribution of mineral deposits, a metallogenic forecast map and mathematical models are prepared.

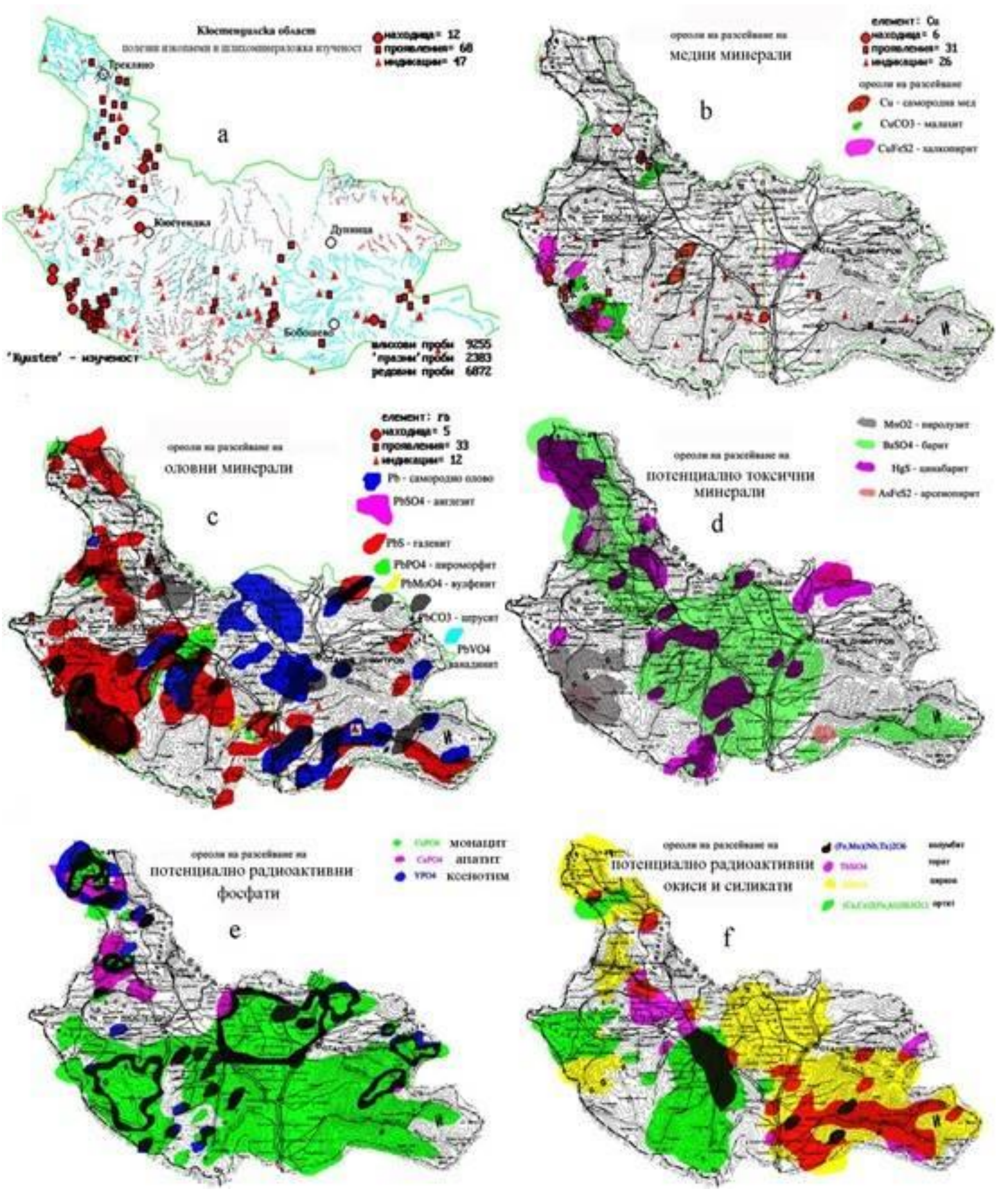


Fig. 5. Schlich-mineralogical Study and Minerals of Kyustendil Region (a); Schlich-mineralogical halos of scattering of: b- copper minerals; C-lead minerals; d-potentially toxic minerals; potentially radioactive minerals: e-phosphates; F-oxides and silicates (Vitov & Sotirov, 2014; Vitov, 1992b, 1994a,b, 1995, 1997, 2005a,b).

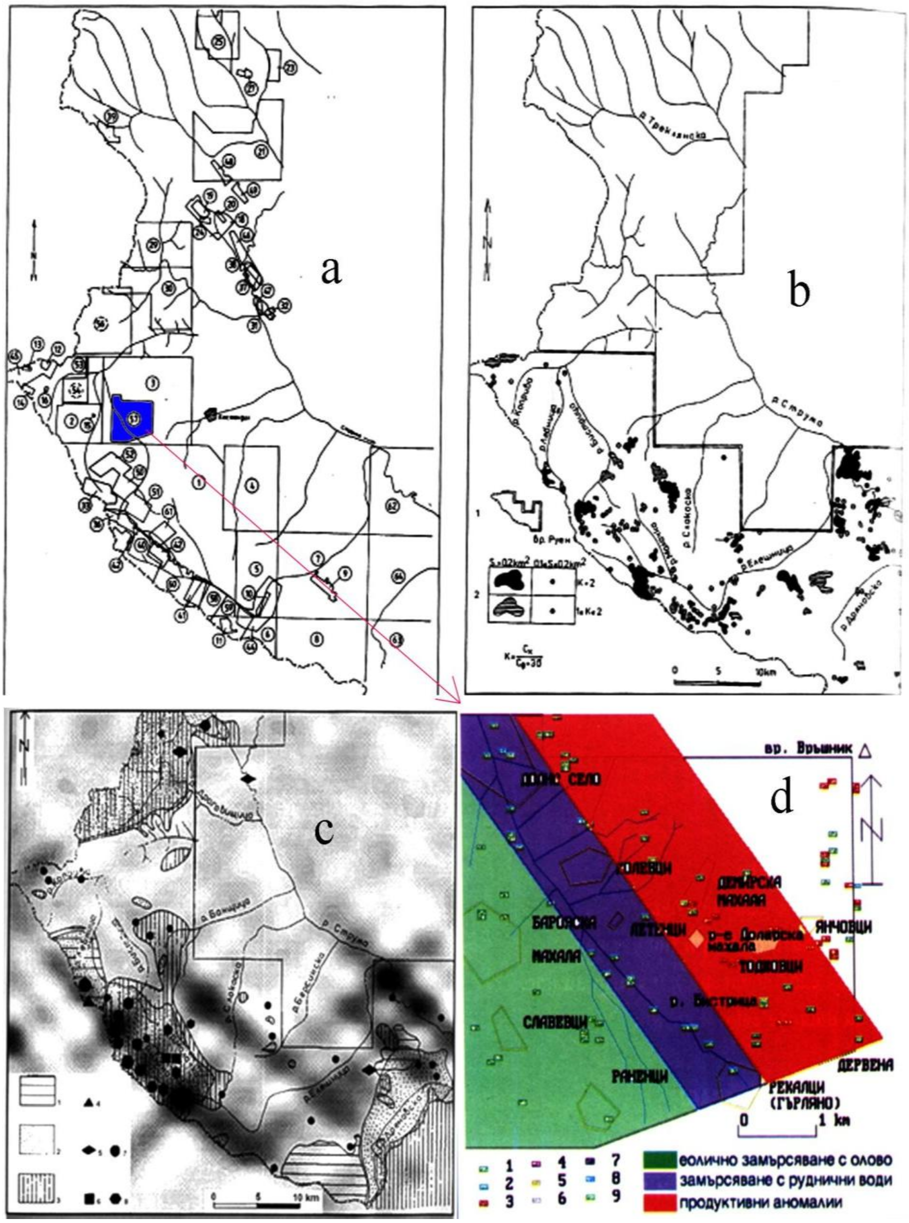


Fig. 6. Geochemical study of the Kyustendil region by the method "Secondary geochemical halos" (a); b-pronounced, high-contrast geochemical anomalies in lead, zinc and copper; c-Fourier model of the distribution of the geochemical field in lead, zinc and copper; d-detailed geochemical assessment of lead contamination in the Kamenishko depression: eolian (from the landfills at Gyueshevo), hydro-chemical (with mine waters from the peak Ruen deposit) and from productive geochemical anomalies in the western slopes of Lisets Mountain (Vitov & Yamakov, 1996; Vitov, 1999a,b, 2000).

5 Results and Discussion

Ore prospecting and extraction data from 1944 to 2010 and future job prospects.

The geological surveys carried out (Tretyakov, Boyan Boyanov, Kiril Iliev, Sapundzhiev, Rayo Dimitrov, Ivan Peev, Asya Kharkovska, Ivan Zagorchev, Nikola Zidarov, Kiril Zinoviev, Metodi Maksimov) search and revisions of minerals show the presence of 187 promising sites. Their research has been discontinued for various reasons, but this is a potential for economic growth in the territory. It is a mistake to look for large and expensive deposits. There are no such anymore. Realities point to the search for small, attractive (economically profitable) deposits with a complex nature and the possibility of waste-free extraction.

Lead-zinc ores in Osogovo Mountain

According to statistics of Milev, Stoyanov, Ivanov (1996), for the period from 1957 to 1995, 3832400 tons of ore with 1.66% lead and 1.06% zinc content were mined in Osogovo, from which 63567 tons of lead and 40780 tons of zinc were extracted, which at modern prices is about 210 million dollars. Part of this money is "stayed" in Kyustendil, as salaries of miners and service personnel, infrastructure (roads, buildings, equipment) and as a memory of youth and prospects for an entire generation. The ruins of the mine and the processing plant in Gyueshevo are also left, as well as the two tailings ponds. About exploration of the deposits and the creation of a processing plant in Osogovo, Bulgaria has spent about 700,000,000$.

In the mining landfills, the material is ground rock mass and ore minerals. There are no such materials in nature and a special methodology should be developed for the study and utilization of these "wastes. There is raw material for the manufacture of cement blocks, bricks, tiles and metallurgical raw material for lead, zinc, copper, arsenic, beryllium, indium, cadmium, silver and gold. If measures are not taken for the disposal of the landfill permanent pollution of the Kamenishko Depression and the section of Corridor 8 passing through these places occurs. The use of ore dumps for inert filler, drainage or for road pavement is a gross mistake - these materials contain minerals of toxic elements lead, zinc, cadmium, beryllium, arsenic.

The ores in Osogovo have been studied with prospects for 50 years of production at a price of 700 $/t of lead. The conjunctural drop in prices to $350/t of lead made mining unprofitable and the mine was abandoned. At the moment, the site of the mine is privately owned, but there are several billion dollars of net profit "buried" in it (a ton of lead today costs about $ 2000, Fig. 3). In these ores there is zinc (sphalerite) with high indium and cadmium contents, in galena (lead mineral) there is silver, the host rocks are enriched with native gold, tungsten-molybdenum ores and beryllium.

When assessing the prospects for ore extraction, the mining strategy must also be taken into account (Yordanov & Vitov, 2002). If the target is maximum profit in the shortest possible time, the "life" of the mine is shortened, while moderate mining with maximum extraction of useful components, waste-free extraction, strict environmental measures at low profit, guarantees a continuous income for the population and expanded infrastructure (trade, agriculture, cattle breeding, transport, industry and crafts). The distribution of lead minerals in the river sands (Fig. 5) and the geochemical anomalies (Fig. 6) indicate the presence of a second productive strip for lead mining Treklyano-Kyustendil-Vlahina Mountain, as well as the potential contamination of soils and waters in the region with lead and lead compounds.

Copper ores in the Kyustendil region (Fig. 5) are known in many places, according to different investigators as Petar Tuparev, Ana Velichkova, Blagoy Anastasov, but the most attractive for development are the Meinsfeld-type copper sandstones (Lower Triassic, Zlogosh) traced as a strip from Kraishte to Vlahina Mountain (Vitov, 2012). For technical reasons (poor testing) they were abandoned by the state at the expense of the Srednogorski copper deposits (Panagyurishte, Medet, Assarel, Ellatzite). The copper content in the ores is 0.5% (modern requirements are for grades above 0.1%) and with appropriate technology (biotechnological ore extraction) they are an invaluable asset (the price per ton of copper is about $ 7000).

The map of copper deposits and minerals of copper in the sands of Bulgaria (Fig. 7) shows that the Kyustendil region and the catchment areas of the Struma and Mesta rivers are promising for the search for copper deposits. In addition to Zlogosh, copper mineralization has been found in the Osogovo polymetallic deposits (chalcopyrite), Lisichi dupki (Tsarna River, skarn-iron ore occurrence with chalcopyrite), in the Kamenishko Depression (Lisets), Dragodan (Boboshevo) and at the foot of the Konyavska Mountain (Dvorishte).

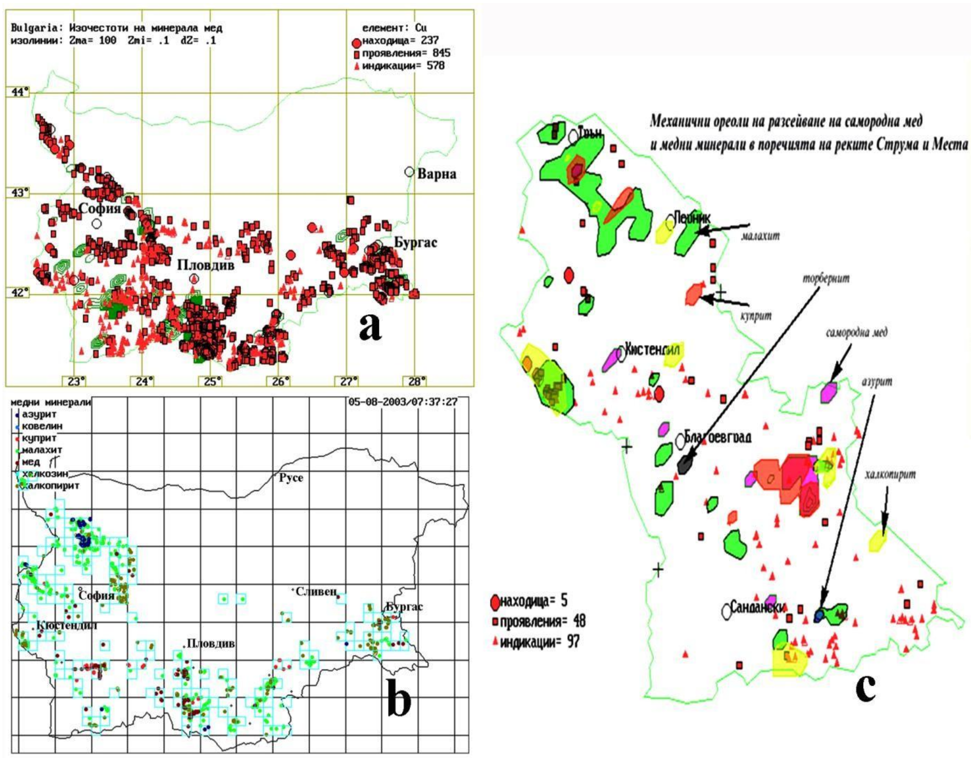


Fig. 7. Distribution of copper deposits, manifestations and indications (a) and copper minerals in river sands in Bulgaria (c). Scattering halos of copper minerals and root deposits and manifestations of copper-containing ores in the catchment areas of the Struma and Mesta rivers (c) (Vitov, 2012).

Gold is an emblematic metal for Kyustendil. Gold was mined here before the Thracians (Garbino), during the Thracians (Treklyano - Sredorek), during the Roman Empire (Perivol - Shishkovtsi), the Middle Ages (Dolno Uyno - Fig. 9, probably Razmetanitsa), during the Ottoman Empire and in modern times - a French company before the war mined gold in the region of Perivol. Studies show that Kyustendil is located at the intersection of stripes in the distribution of gold on the Balkan Peninsula with very promising areas for searching for local gold minerals (Fig. 8). The Kyustendil region is one of the most gold-bearing territories in Bulgaria. The studies of the Struma River showed reserves of 20 tons of placer gold (Vitov, 1990,2002a,2005a,b,2008,2009,2015; Milev et al. 2007; Tsintsov & Radoykov, 2007; Bakalov & Zhelev, 1996; Vardev, 1995; Tretyakov, 1955).

The extraction of gold from the river deposits was prohibited due to the danger of disturbing the water mirror of the groundwater in the apple orchards.

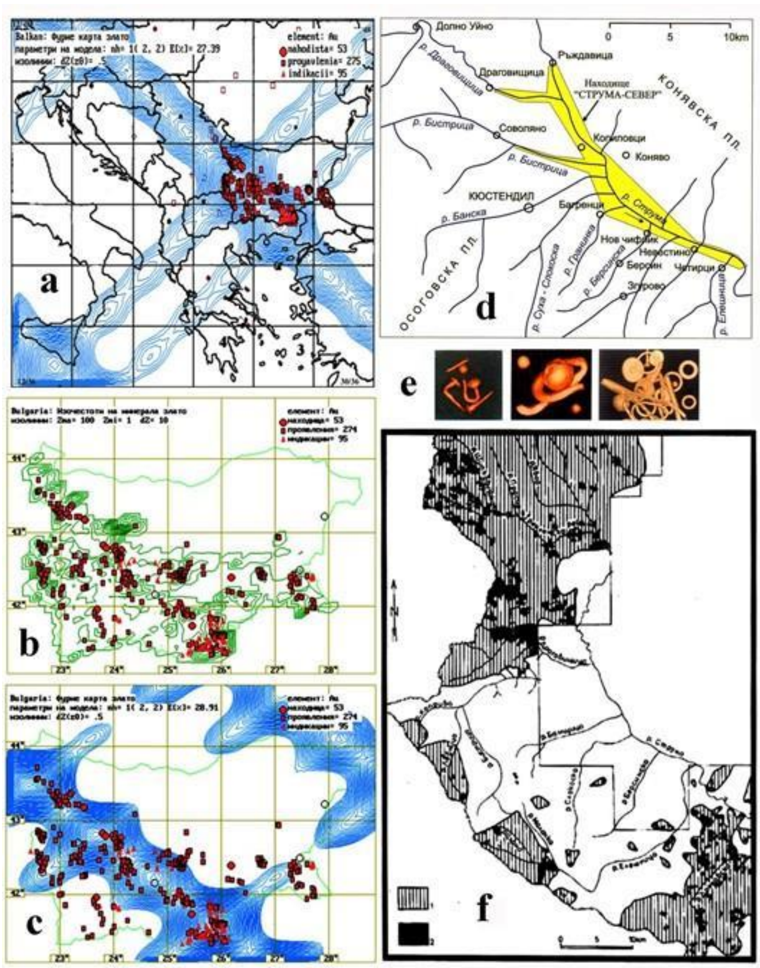


Fig. 8. Regularities in the distribution of gold in the Balkan Peninsula (a) and in the river sands of Bulgaria: probability of gold discovery (b) and Fourier model (c) of gold distribution (forecast for demand for gold minerals). Placer deposit (d) of gold "Struma-North" with gold artifacts (e). Schlich-mineralogical forecast for the demand for indigenous gold minerals in the region west of the Struma River – Kyustendil region (f): 1-second forecast (nourishing provinces); 2-first forecast (nourishing districts) (Vitov, 2012).

After "democratic changes", five companies officially (and without a number of unofficial "companies") have mined gold with permits from the municipality of Kyustendil in the richest sections of the river, declared "zero mining". At that time probably about 2 tons of gold were extracted and the water balance of the Struma River was disturbed. The groundwater has dropped by two to four meters (visible on the bridge near the village of Tarnovlag). The unregulated extraction of gold along the river and tributaries continues today with the application of prohibited methods and means - seizure of the richest areas of the deposit, use of surfactants and mercury amalgams.

Recently, the company "Dundee" (Canada) has carried out research for the indigenous gold bearing of the region and has marked several areas for mining. But Dundee has a plan, but it will not mine gold because of the priorities of the Municipality of Kyustendil - the development of balneology and fruit growing. The gold mined by private companies is also not in Bulgaria. It is in the interest of the municipality and the people of Kyustendil to have a state or municipal enterprise for exploration, extraction and purchase of gold with the subsequent establishment of a municipal investment bank with a gold reserve. It is necessary for gold to become a state policy.

The draining of gold from the region of Kyustendil in antiquity and the Middle Ages and its export to Rome and Ottoman Turkey contributed to the enrichment of a narrow stratum of the population – officials and aristocracy. These circumstances alienated the population from searching, exploration and extraction of minerals. Yordan Ivanov discovered that the miners in the region were called "utmans" – people seeking enrichment and creating problems for the population (Ivanov, 1906).

The detachment of the population from the main resource of the territory – minerals – negatively affects both the migration processes and the self-awareness of the Bulgarians, turning the people of Kyustendil into disposable people. Resources that have the opportunity to benefit people become the reason for their depersonalization and regression. Separately – the ignorance and carelessness of the use of these resources. The blind application of the principle "to protect the natural environment", with which people are exposed for political or business purposes and the closure of the mining is a path to economic decline, population reduction and subsequent settlement with nationalities alien to the region. This has happened many times – the Thracian tribes Dentheletae and Peoni, probably the Medes are also victims of this process. Over the centuries, Kyustendil has constantly fallen under foreign rule during periods of weak government. Mining in medieval Bulgaria was carried out by Saxon miners and "shopi" - local people living in huts around the mines. The closure of coal mines, geological surveys, ore mining in Osogovo is the reason for the negative birth rate in Kyustendil today. At the same time, transport, agriculture, numerous antennas, solar plantations and illegal landfills on fertile land, as well as poor management, damage nature many times stronger and faster.

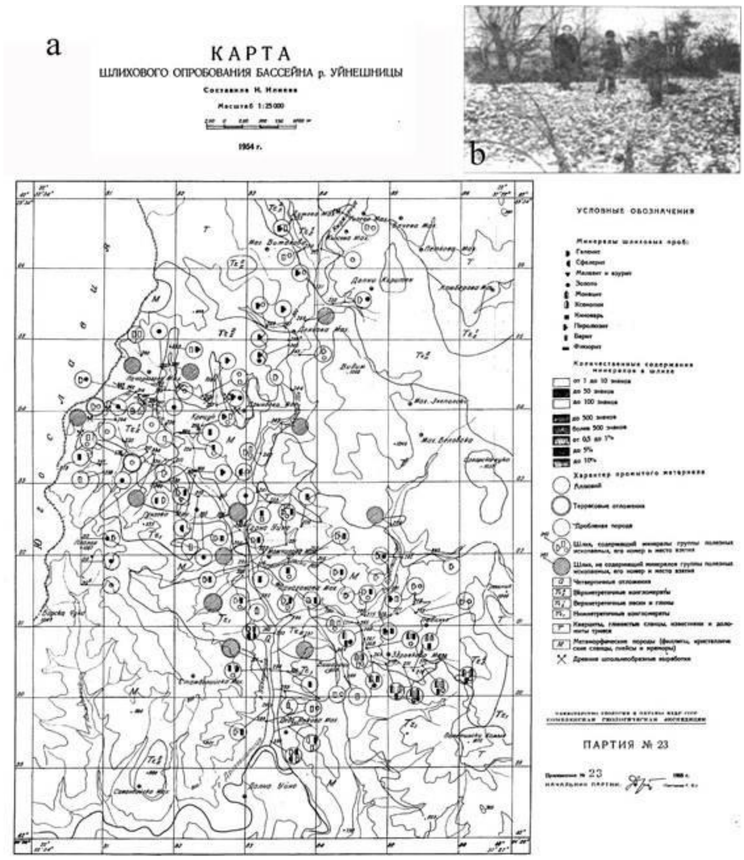


Fig. 9. Archive schlich-mineralogical map of Gorno Uyno (a) indicating the locations of medieval gold mines (Tretyakov, 1955). Photo of stone piles (b) from gold mining on the Uynestitsa River (Dremsizova & Slokoska, 1978).

The gold rush in the Kyustendil region is analogous to the gold rush in California, the destruction of apple orchards in an effort to extract gold from the river, described by Zweig (1989). The only way to prevent the public disaster is the firm intervention of the Municipality of Kyustendil and the regional government with regulations, law and law.

Mercury in Kyustendil has been known to the population for a long time as magic. It was sold by Kolushki Cadences (Turk.) in the form of "red pebbles" (the ore of mercury is mercury sulphide – cinnabar, red crystals, "dragon's blood"). It is as an ethno-phenomenon "magic of mercury" (Zahariev, 1918).

The finds of mercury ore grains in the area of Shishkovtsi, Treklyano-Sredorek, Crnata Skala and geochemical anomalies with mercury content per ton of soil in the region of Garbino show a high potential for searching for mercury and gold-mercury ores. There is a danger of environmental pollution with mercury during thermal processes - production of bricks and lime, burning coal, forest fires, stubble burning (Fig. 10). There is a great danger of pollution with mercury emissions from the fires in the urban garbage heap near the village of Radlovtsi. The northwest winds carry these emissions right in the centre of the city of Kyustendil. An indicator of a high mercury content are the common finds of "white gold" on the rivers, which turns yellow when heated (gold-mercury amalgams), as well as drops of native mercury in the river deposits of the Struma River. The largest mercury anomalies in Bulgaria are located in the region of Sredorek-Treklyano-Ushi (Kobilski kamak) in Kyustendil Kraishte and Tran region. It is necessary to investigate the distribution of mercury in the air, soils and waters of the Kyustendil valley and adjacent lands, to clarify the sources of mercury and to take adequate measures to prevent mercury contamination (Vitov et al., 2006; Dimitrov & Vitov, 2009; Atanasov et al., 2005; Vitov & Marinova, 2005a,b, 2009).

Tin

In Lishev's monographic work, "The Medieval Towns in Bulgaria", it is reported that in Kyustendil, during the reign of Tsar Ivan Asen II (Velbazhd), there were Saxon miners and metallurgists who paid taxes in kind – tin, silver, gold, copper and iron. The city council consisted of 50 representatives of guilds of craftsmen, of whom 15 were Saxons. Today, there is no data from geological surveys for tin mines in the territory. There is a single find of cassiterite (tin dioxide, tin ore) in a tributary of the Dzherman River (Slani dol); Toponymic evidence is word "Kalaidzhiyski kamak" – a peak in Western Rila and the toponymic traces and archaeological monuments described by Yordan Zahariev in Piyanets for medieval ore mining (Sasi neighborhood).

There is an application for a concession for the extraction of tin from Maksimov Avenue in the region of Gorno Uyno and a letter to the State Archives that Stanimir Iliev Derlipanski has provided grains of tin ore (probably cassiterite) for research to Tsano Raykov (Fig. 14). From a metallogenic point of view, the fluorite mineralization around Osogovo must be accompanied by tin deposits. It can be assumed that in Brezovski Rid and in its southern branch Sasanski Rid, in the land of the village of Stradalovo there were tin mines in the Middle Ages.

The price of tin is high (about 20000 $/t) and if we have such deposits and develop them, there will be economic growth. In the prepared forecast for demand for tin ore deposits in Bulgaria, it is found that the districts of Kyustendil and Blagoevgrad have a high potential for discovering such deposits (Smirnov et al., 1981; Zahariev, 1949; Vitov, 2002b) (Fig. 11).

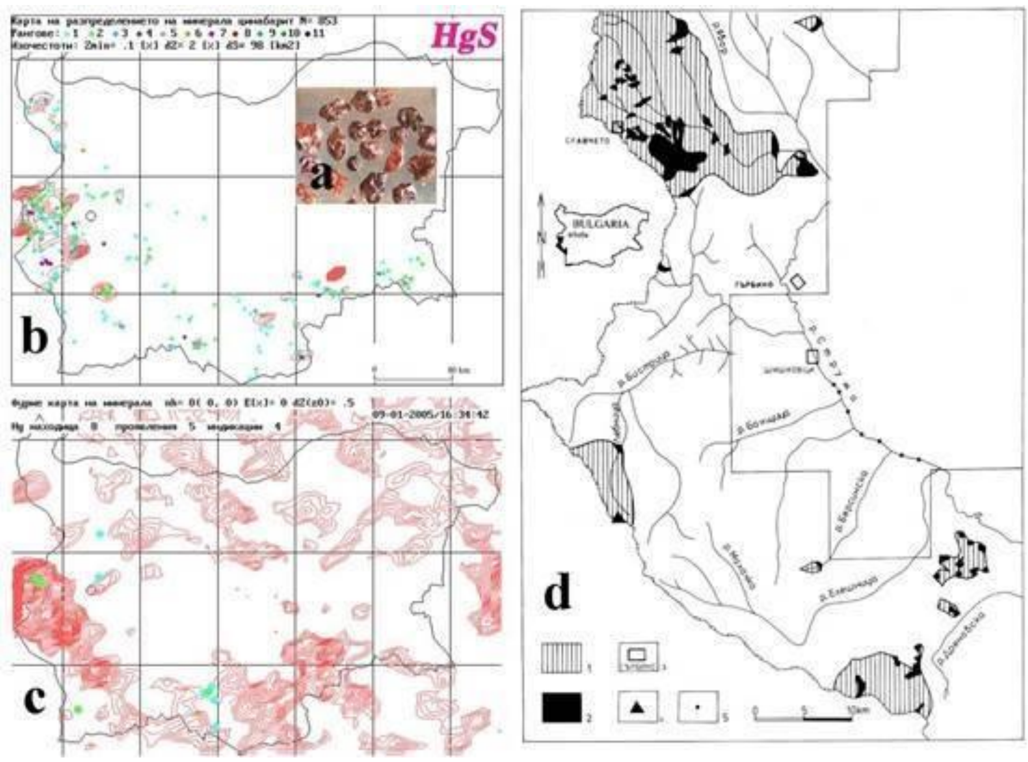


Fig. 10 Mercury mineralization in Bulgaria and Kyustendil region: a- cinnabar grains in the sand; b-finds of cinnabar grains in Bulgaria and probability of their discovery; c- Fourier probability model (forecast for search for indigenous mercury deposits); d- schlich-mineralogical forecast for search for indigenous mercury minerals in the region west of the Struma-Kyustendil River: 1-second forecast (nourishing provinces); 2-first forecast (nourishing areas); 3- areas with pronounced cinnabar anomalies: Hump- geochemical halos of mercury; Shishkovtsi- schlich-mineralogical halos of scattering; 4 - cinnabar manifestation of Bozhderitsa (Gyueshevo); 5-Finds of drops of nugget mercury and gold-mercury amalgams ("white gold") in the placer of the Struma River (Smirnov et al., 1981; Zahariev, 1949; Vitov, 2002c).

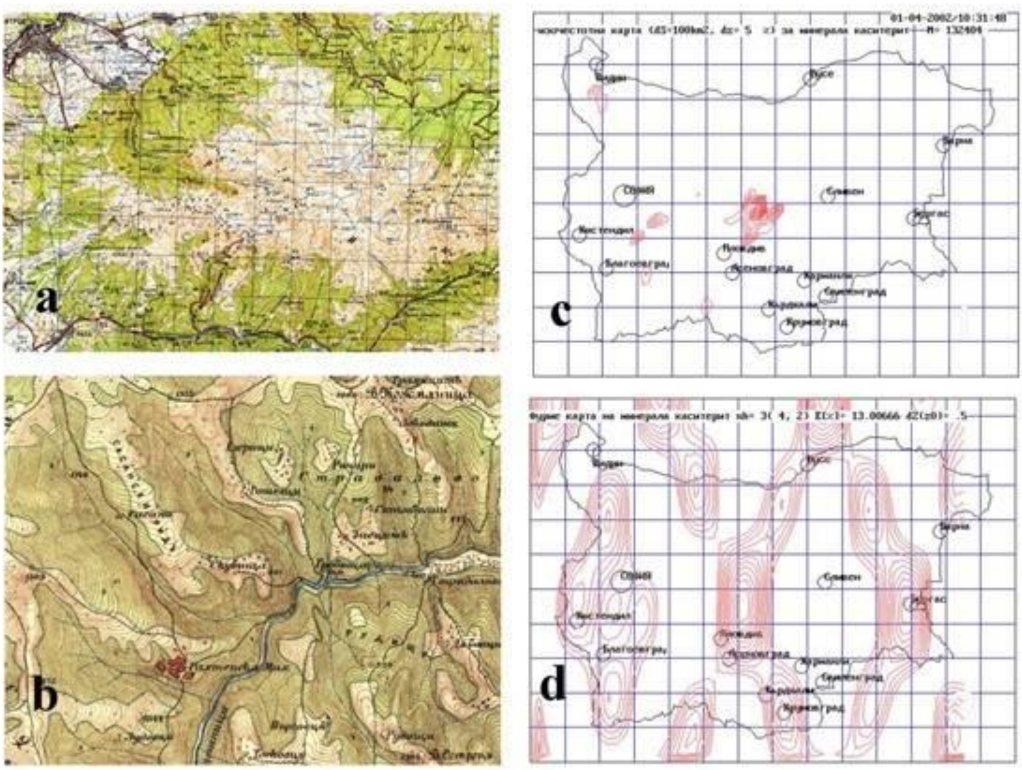


Fig. 11. Indications of tin ore in the Kyustendil region: a-Kalaydzhiyski kamak peak in the Rila Mountains – toponymic evidence of tin grains; b-topographic map "Rakovo", (M1:50000, ed. 1903) with toponymic traces in the land of the village of Stradalovo for the extraction of tin (?) ores in medieval Bulgaria: Sasanski Rid, Sasi neighbourhood and Rudishte and Rudishta localities; c- distribution of the probability of detection of

tin mines in Bulgaria; d-Fourier model – forecast for demand for tin tools in Bulgaria (Smirnov et al., 1981; Zahariev, 1949; Vitov, 2002a).

Fluorite.

Around the Osogovo polymetallic deposits there is a belt of fluorite mineralization and minerals (Tsrna Reka, Shopski Dol) and probably related tungsten-molybdenum manifestations. They have not been studied, but there is reason to expect that they are industrial. In 1982, Ivan Zagorchev and Milka Ruseva discovered a fluorite occurrence in Zidintsi – the village of Gorno Rakovo. Ditch studies showed that Zidintsi has prospects for quarry mining of 360,000 tons of fluorite at a cost of 540 million dollars at the worst performance (length 3 km, depth 100 m, cross-section 2 m and 20% CaF contents). Fluorite is suitable for growing crystals of optical quality (Fig. 12) (Dimitrov, 1945; Zagorchev & Ruseva, 1982; Vitov, 1993; Mukhovski & Vitov, 1995; Mukhovski et al., 2014; Vitov & Konstantinov, 2001).

The extraction of fluorite is environmentally friendly and profitable. SODI Co. extracts 50,000 tons of fluorite per year from Chiprovtsi and exports it to Spain. Fluorite is traded in batches from 1 to 50 tons, which means that resources for an entire chemical industry have been drained from Bulgaria - hydrofluoric acid for nuclear fuel processing and chemical applications, rocket fuel, fluoroplastics, glass, cement industry, metallurgy, optical materials for lasers, telescopes, microscopes, binoculars and cameras. Fluorite optics is the basis for the production of microelectronic chips. Fluorite is a strategic raw material for the United States and a means of extracting several million dollars for the Bulgarian treasury.

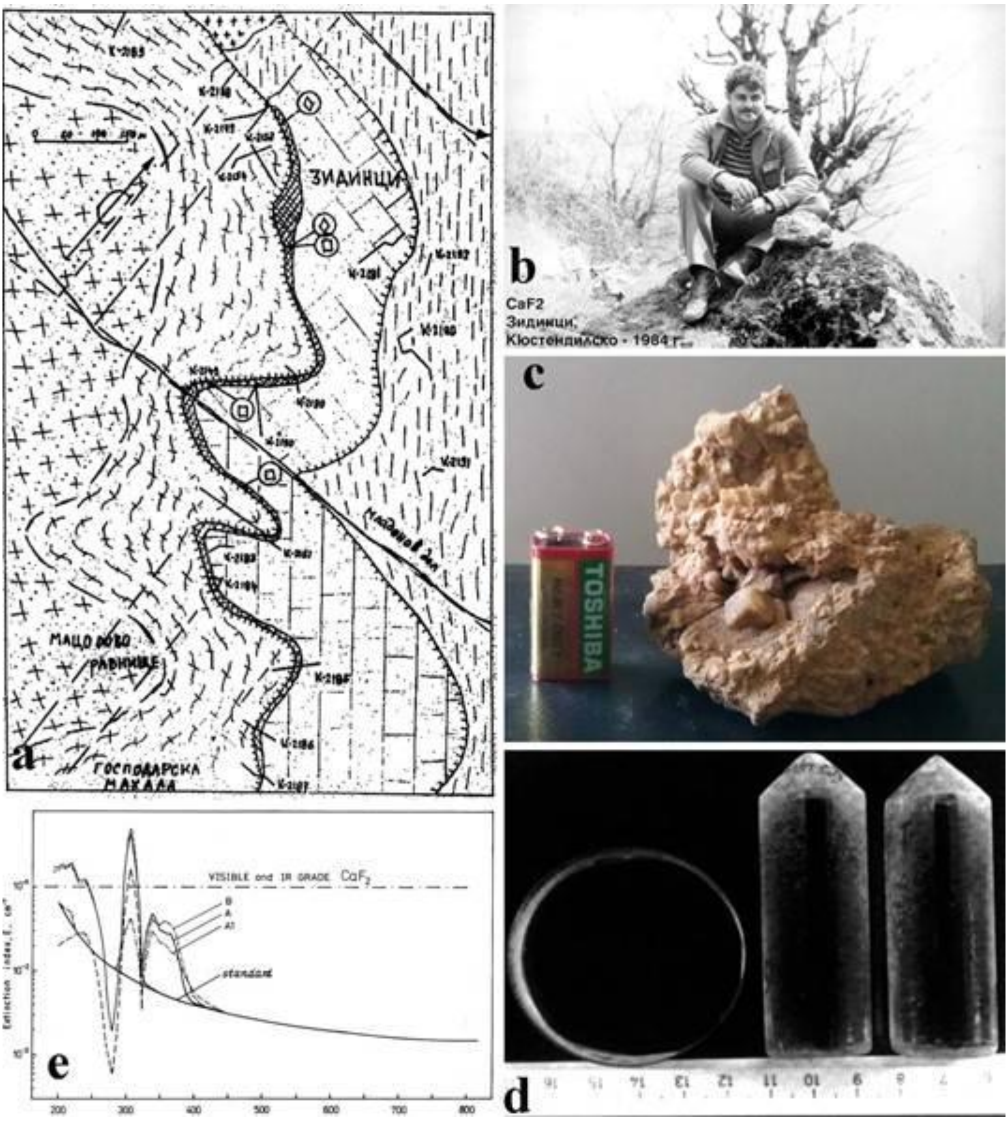


Fig. 12 Fluorite occurrence of Zidintsi: a-geological map; b-field image from Mladenov dol (the author Oleg Vitov); c-quartz-fluorite drusen; d-optical crystals grown with Zidintsi material; e-optical characteristics of the regrown crystals (Dimitrov, 1945; Zagorchev & Ruseva, 1982; Vitov, 1993; Mukhovski & Vitov, 1995; Mukhovski et al., 2014; Vitov & Konstantinov, 2001).

Gemstones

Minerals from the group of precious stones were found in the schlich-mineralogical samples (mineral composition of the sands of the rivers): spinel (23), tourmaline (470) and corundum (ruby) (75). The brackets indicate in how many samples these minerals were found. Garnet also was found in the mountain Konyavska.

Given that the sampling density is about 1 sample per square kilometre, it follows that this figure also shows how many square kilometres of the territory are potentially promising for the search for root deposits of precious stones.

Emerald

In the pegmatite veins around the Seven Rila Lakes, there are beryl crystals (emerald, aquamarine) with a high value (Kostov, et al., 1964). For years, German tourists have been camping there in tents and leaving satisfied with the hospitality of the mountain and the people in Bulgaria with pockets filled with emeralds. For their convenience, a lift has been built. According to data from the Internet, the price of an emerald is from 60 to 240 dollars per carat. One carat is 0.2 grams. weight 3 grams and cost from 9000 to 36000 dollars. According to Petrusenko, a specialist from the National Museum of Natural History - Sofia, there are also pencil-sized crystals. They cost more.

There are trenches in the mountainside and sad thoughts about the decision of the Bulgarian government from 1964. to liquidate the subject "Geology" in the high school education. The Bulgarian is illiterate - he does not see the difference between quartz, calcite and fluorite, not to mention the definition of emerald, and easily succumbs to suggestions such as "Bulgaria is poor in minerals. What is in Bulgaria was discovered by German geologists before the war and developed by Russian geologists after the war."

The truth is that the science of geology is constantly evolving with new methods, new tools and new theories. The mineral market is very dynamic – yesterday's profitable deposits are sinking into bankruptcies, while mineralogical finds, manifestations and indications are causing a boom in ore mining. Lithium deposits are currently being sought. However, studies for lithium have not been carried out in Bulgaria (Vitov, 2014b).

For the competent use of the territory, it is necessary to create personnel and invest in a systematic study of the earth's interior. Data on geological structure and resources are strategic information and should be stored and processed with the thought that this is the basis for the wealth of our country and a guarantee of our independence.

In the collection of Simeon Maximov in the Regional History Museum – Kyustendil there are several pieces of broken large aquamarine crystals. There is no record of where they are from, but it is certain that they are from Bulgaria.

About diamonds in Kyustendil region

Diamonds are many times more valuable than emerald. In an article by Assoc. Prof. Zheko Popov was reported that Mr. Stanimir Iliev Derlipanski (1906-1987) from Kyustendil has discovered diamonds in the region of Kyustendil. In the documentary heritage (State Archives) documents on the case are kept (Fig. 14). Mr. Derlipanski found in the Peshtera-Zemen region a diamond weighing 170 grams (850 carats) and small diamonds in the Garbino region. Small diamonds were studied at Moscow State University-Sofia (1974, Assoc. Prof. Slavcho Mankov, personal message), and the large diamond was stolen (or lost). The search for diamonds in the Garbino region was also inspected by an expert group headed by Assoc. Prof. Slavcho Mankov (oral information) in the presence of Mr. Derlipanski, did not yield results.

The carried out schlich-mineralogical studies on the mineral composition of the river sands in Bulgaria and the sands in the districts of Pernik and Kyustendil showed that Bulgaria has prospects for the discovery of diamond deposits (Fig. 15). The diamond sites indicated by Mr. Derlipanski are located in areas (mineralogical anomalies) with prospects for the detection of diamonds "kimberlite type" and "alpine type ultrabasites". In the geological map of the Garbino ore deposit, by Parvanov, Vatsev, Kraevski (Fig. 16) diamond-bearing rocks are reflected – post-Triassic peridotites, gabbro and gabbro-diorites (dikes), as well as Perm-Triassic conglomerates (the Ural diamonds are in Permian sediments).

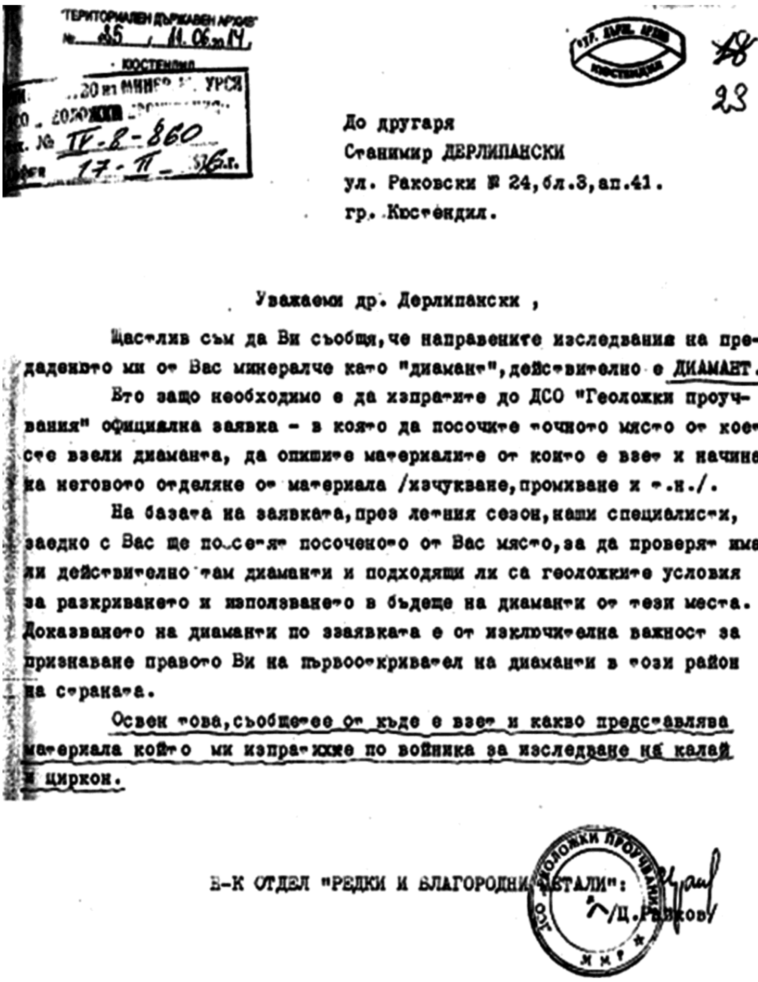
To find the diamonds, specialized sampling must be carried out with samples of 5 tons of rock. If at least one carat (0.2 g) of diamonds is found, the deposit is industrial.

Rock cladding and building materials River sands

The district of Kyustendil was examined with 9255 schlich-mineralogical samples, of which 2383 were without mineral composition ("blank samples"). The examination of the samples showed the presence of 51 mineral species and varieties – minerals of lead, copper, tungsten, molybdenum, mercury, minerals of rare and scattered elements, heavy rock-forming minerals (Tables 3 and 4).

The distribution of manganese, barium, mercury, arsenic and copper minerals is shown in Fig. 5.

Osogovo has a large mineralogical anomaly for pyrolusite – black manganese dioxide. It is a product of the decomposition of the silicate mineral rhodochrosite and stains soils and rocks black (Sazhdanyk, Tsrni kamak, Tsrna reka) and causes darkening of the leaves of plants (Tsrnotrav). The waters of this area are saturated with manganese and their use for drinking needs, without additional treatment from the Slokoshtitsa dam, is not desirable.



До другаря
Станимир ДЕРЛИПАНСКИ
ул. Раковски № 24, бл.3, ап.41.
гр. Кюстендил.

Уважаеми др. Дерлипански ,

Щастлив съм да Ви съобщя, че направените изследвания на предаденото ми от Вас минералче като "диамант", действително е ДИАМАНТ.

Вто защо необходимо е да изпратите до ДСО "Геоложки проучвания" официална заявка - в която да посочите точното място от което сте взели диаманта, да опишите материалите от които е взет и начина на неговото отделяне от материала /изчукване, промиване и т.н./.

На базата на заявката, през летния сезон, наши специалисти, заедно с Вас ще посетят посоченото от Вас място, за да проверят има ли действително там диаманти и подходящи ли са геоложките условия за разкриването и използването в бъдеще на диаманти от тези места. Доказването на диаманти по заявката е от изключителна важност за признаване правото Ви на първооткривател на диаманти в този район на страната.

Освен това, съобщетее от къде е взет и какво представлява материала който ми изпратихме по войника за изследване на калай и циркон.

В-К ОТДЕЛ "РЕДКИ И БЛАГОРОДНИ МЕТАЛИ":
/Ц. Ра..ков/

Fig. 13. Archive document from the State Archives – Kyustendil, from which it is evident that Mr. Stanimir Derlipanski discovered diamonds and tin ores in the region of Kyustendil.

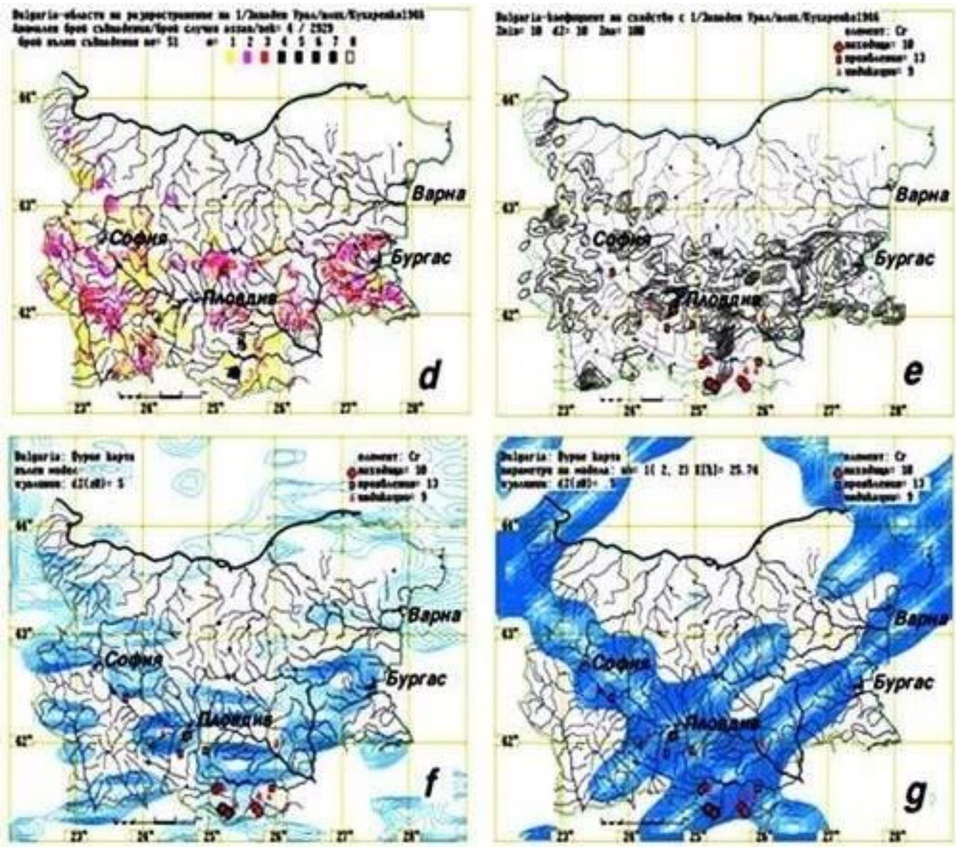


Fig. 14. Schlich-mineralogical forecast for demand for type diamonds "Western Urals" in Bulgaria: d-distribution of the number of coincidences on the territory of Bulgaria; e-probability of coincidence with the standard; f-Fourier probability model; g-Fourier forecast for diamond search with the "Western Urals" standard (Popov, 2010; Vitov, 2014).

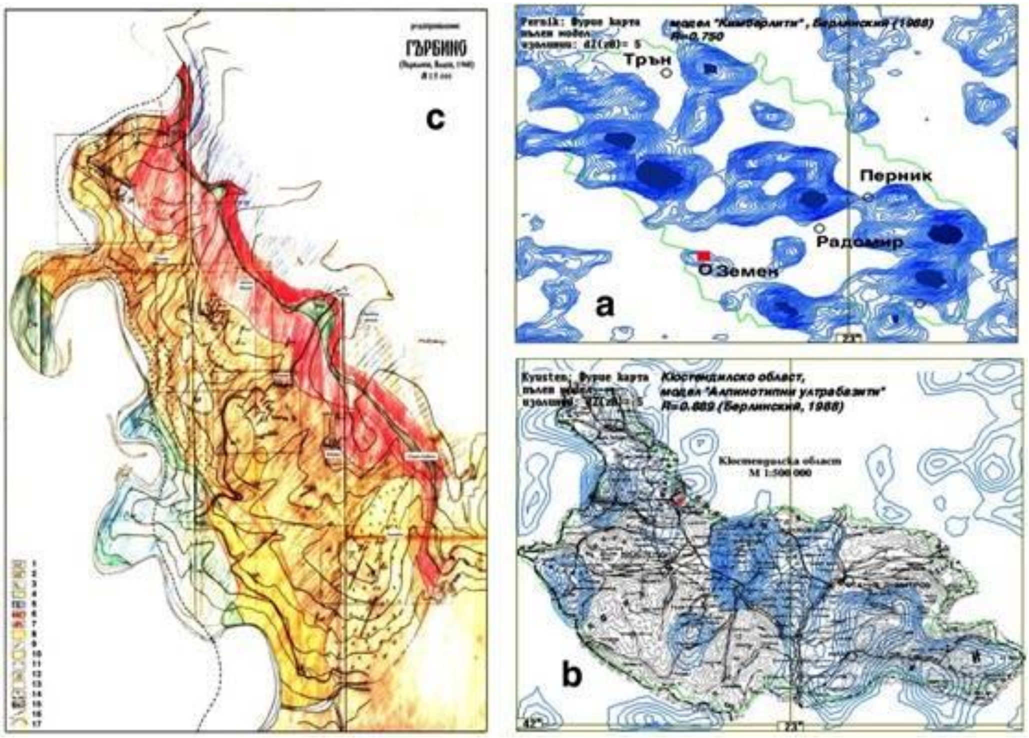


Fig. 15. Schlich-mineralogical forecast for demand for diamonds in Pernik district (a) and Kyustendil district (b). The places of diamonds described by Mr. Derlipanski are within the range of mineralogical anomalies (Peshtera - Zemen and Garbino - with a red square). Geological map of Garbino, which shows alpine-type basic and ultrabasic rocks (green) and Perm-Triassic sediments (red) with prospects for diamond discovery (Popov, 2010; Vitov, 2014a).

Numerous cinnabar anomalies (mercury sulphide) mark areas where it is contraindicated to light fires, burn stubble or use clay for brick production due to the fact that above 180°C, all mercury compounds decompose and mercury flies into the air. Breathing mercury vapor causes severe, incurable physiological damage, mental illness and death. It is desirable to maintain young forests in these areas and to watch out for forest fires.

Arsenopyrite, when decomposed, releases highly toxic arsenic compounds that get into the grasses for grazing livestock, from there with the milk and meat on our table.

Barite is on the periphery of polymetallic deposits and is harmless, but when heated, it can change to toxic barium compounds.

Copper minerals are potentially toxic. In acidic waters and soils, they become active and begin to move, saturating water and soils with poisonous copper compounds.

The distribution of radioactive phosphate, silicate and oxidizing minerals shows (Fig. 5) that the Kyustendil region is saturated with minerals of rare and scattered elements. These are heavy minerals.

Taking sand for plasters was safe in the past. Sand is taken from the upper parts of river sediments, in which there are generally light minerals (quartz, feldspars, carbonates and mica). Today, sand is mined with heavy machinery from a great depth of sediment, whereby the participation of heavy, radioactive minerals increases.

The use of such material for plasters and concrete leads to saturation of the indoor air with the radioactive gas 222Rn (radon), which increases the risk of lung cancer. elements of great value – gold, zirconium, hafnium, thorium, uranium, niobium and tantalum. The release of heavy minerals is not a problem. It is carried out with elementary enrichment locks. It is about their organized harvesting, responsible storage and competent use (Vitov & Yamakov, 1996; Vitov, 1999a,b, 2000).

Coarse stones, gravel and boulders from the rivers

The study of the gold-bearing placer along the Struma River (Mr. Panayot Bakalov, Mrs. Hristina Ivanova, Mr. Tsano Raykov) is accompanied by a study of river sediments – granulometry and petrographic spectrum. It was found, that about 10% of the sediments are large, rounded pieces of rose quartzite, milky-white quartzite, translucent quartzite ("pork quartz" – looks like bacon), black quartzite (lydite), pieces of green diorite, white granite granites, variegated gneisses, rarely marble and limestone. This variegation is also evident in the medieval and ancient constructions in Kyustendil and the surrounding area. The rock pieces are extremely strong, but they are rounded and difficult to build with them. Master masons have created a style specific to the region - a ceramic cage (rectangular or hexagonal) filled with boulder and mortar.

The combination of red ceramic tiles with white mortar and coloured rock pieces is amazingly beautiful. The roundness of the pieces and the harmony create peace and comfort for the eye. This technique is possible with an abundance of boulders in the extraction of gold from rivers and river terraces – boulders are waste from gold mining. Today, such boulders and pieces of rounded gravel are used to make attractive fences, cladding buildings and for interior decoration - staircases and panels.

Quartzite pieces were not used in construction, but were piled up in elongated heaps – mounds along rivers and near open-pit mines in antiquity. A large part of them were used for grinding bodies in Kremikovtsi, for the production of quartzite thermal insulation of furnaces and for glass production. At the station in Kyustendil there are remnants of chambers of quartzite, which were exported from the area.

Coarse stones in the rivers is a raw material for the production of construction panels at the factory in Kopilovtsi – it is free of clay impurities, clean and binds well to cement. The panels are of high quality. Unfortunately, no exploration of new coarse deposits is carried out and the factory difficult supply raw materials. At the moment, gravel is being dug from the factory yard - an over-floodplain terrace on the Struma River. The boulders are crushed and sold like crushed stone.

The plant in Kopilovtsi is not interested in separating heavy minerals and gold from coarse – the laws, regulations and administrative problems associated with such activities are unbearable for its owner. He is satisfied with the work he does and the profit of the company.

A possible solution to the difficulties of the company in Kopilovtsi for raw material is to use the sludge in the barrages and barrage systems in the area. It is borne in mind that in order to function, the barrages must be empty. When they are used for a long time, they are filled with forest soil, sand and gravel, draining the groundwater, draining the area of the barrage and saturating the surface waters with heavy metals and salts. Irrigation with barrage water leads to degradation of agricultural lands and causes a deficiency of humus and trace elements. The raking of sediments from the barrages and their washing will have a beneficial impact on the environment, water regime, climate and agriculture and will provide raw material for the creation of concrete panels and elements (Vitov & Nikolov, 2006).

Rocks for cladding and constructions

Construction Sandstone

At the entrance to the city of Kyustendil, at the intersection of Dupnitsa and Sofia, there is an attractive retaining wall built of blocks of grey-green coarse-grained sandstone. In combination with the climbing vegetation and flower beds, it creates a unique colour and vision for the city. A similar sandstone is found in the entire Kyustendil valley, at the foot of the Konyavska Mountain, east of the Struma River (Tavalichevo, Katrishte, Gorna Grashtitsa and elsewhere). Mining can be done with quarries and appropriate equipment. The massive and attractive view, easy extraction and demand for rock facing materials creates an opportunity for the utilization of this raw material, but crushing it into sand is an unprofitable operation, moreover, it is equivalent to crushing marble statues for mosaic.

Rhyolite

In the region of Dolno Rakovo there is a volcano with a strange name Mount "Popova Shapka" that died out ten million years ago. It is built of massive rhyolites - volcanic rocks with a high content of silica, pink-red and grainy. They are easy to process and are used for cladding representative buildings. In Sofia, such rhyolite (from the Eastern Rhodopes) is used to build the cladding of the Central Department Store, the Presidency and the Council of Ministers.

During the exploration of the area around "Popova Shapka" for lead-zinc tools with core drilling, whole cylinders with a diameter of 45 mm were extracted from rhyolite with a length of more than four meters, without cracks. Obviously, rhyolite from "Popova Shapka" is an invaluable raw material for rock cladding materials. Blasting works should not be used in the exploration and extraction of such raw materials, due to the danger of cracking the rock and the impossibility of extracting entire blocks. There are similar volcanoes and volcanic throats on the border with Macedonia (Gyueshevo-Dolno Selo).

Osogovo granite.

In the spring parts of the rivers Vodenichnitsa and Plaviloto there are abandoned quarries for the extraction of granite paving stones. The massive asphaltization of the roads has made these paving stones "superfluous" and the quarries have been abandoned. After 1990, a group of young unemployed "businessmen" – former geologists from Osogovo organized the transportation of the remains of manufactured paving stones to Austria and sold them at a price of 75 DM per ton – not a bad price at that time and saved their families from starvation. With good marketing, these quarries can work today – the granite is very strong, the paving stones are colourful and beautiful. They are in demand for the decoration of representative buildings (the station in Kyustendil), villas and areas for recreation and recreation, sidewalks and alleys.

Osogovo granite, as a rock facing and building material, has a history - most of the sarcophagi, columns, capitals and bases from antiquity in the region are made of coarse-grained Osogovo granite. The plinth of the Pautalia fortress is also built from this material - large, well-processed quadra. In search of quarries for the extraction of this granite, a study was carried out by Prof. Todor Marinov (Univ. of Mining and Geology (MGU)-Sofia). Two Years excavations in the town and Osogovo Mountain were carried out. It was found that it was indeed granite from Osogovo, but no quarries were found. During geological surveys in the Kyustendil valley in connection with the prospecting and exploration of gold-bearing placers (Panayot Bakalov, Krastyo Krastev, Venelin Zhelev, National Geofund, 1974-1978), it was found that the deposits in the region are fluvio-glacial (Vitov, 1978, MGU - diploma thesis) and there is reason to expect that the hills near Vartashevo and Zilintsi are frontal moraine (Gramazhdano, Gramage) and the blocks of Osogovo granite are dragged from the mountain by muddy streams. In a map of the geologist Lazar Vankov since the beginning of the 20th century, there has been a granite quarry above the village of Zhilintsi (Senokos area) – granite blocks dragged from Osogovo Mountain have been broken (Vitov & Nikolov, 2006). During excavation works for laying a power line, a gas pipeline and others in the section between Kyustendil and Garlyano, huge edged pieces of Osogovo granite were dug up. The rock pad is scraped and flat. It is an outwash plain, also called a *sandur* аt the gneiss periphery of the mountain. The valley of the Bistritsa River between Garlyano and Srebarno kolo at the end of the 19th century was described by the Czech Mr. Irichek in "Travels in Bulgaria" as a glacial valley with moraines of Osogovo granite and "sheep's humps" in the gneisses. These facts point to a hypothesis that the artifacts of Osogovo granite are materials from glacial moraines in the vicinity of the city. This is also the recommendation of Vitruvius - fortresses to be built from local material. We have a similar case in the village of Porominovo with the remains of an ancient temple of Sabazius. There the construction was also made of granite, but the architectural elements are made of different types of granite - made of glacial moraines from the valley of the Rilska River, while Pautalia was built exclusively from Osogovo granite (Vankov, 1900; Nenova, et al., 2008).

The millennial use of the moraines for construction has led to the complete liquidation of the moraines in the area. To search for granite for construction in the sixties of the twentieth century, a study of the Osogovo granites with drilling and ditching works was carried out (Velichkova, 1973). It was found that the granite has grappled (decomposed to a state of crumbly sandstone) to a depth of 20-100 meters, there is strong crushing and large blocks cannot be removed. Moreover, in some samples the presence of lead up to 5-10% was found - an indication of additional decomposition of rocks from ore processes. Thus, the Osogovo granite is a problem for the search for healthy sections of the mountain, with the possibility of quarrying massive blocks.

Marbles

An article "Vain hopes for a marble quarry" appeared in the local press, which described the creation and bankruptcy of a marble quarry in the land of the village of Goranovtsi. The region is built of various types of gneiss, schist and marble cores crushed by tectonic processes. There is an old abandoned marble quarry from the distant past. Marbles are of poor quality, often pigmented, cracked and without stable parameters. Kernels of strong, white, sugary marble are rarely found.

Young people from the received permission from the municipality, take out a loan from the bank, invest in equipment (excavator, crusher, sieve and van) and start marble mining with the production of mosaics in envelopes of 15

Kilograms. This mosaic was sold at the market in Kyustendil. The wide variety of colours and sizes of the pieces made the mosaic an attractive commodity – people chose what they liked.

After a month, the company was blocked by law enforcement officers due to illegal use of the land (protests of owners within real limits), the Ministry of Forestry – for the destruction of the forest fund, for lack of permission from the Ministry of Environment and Water, a bunch of other irregularities. Under this pressure, the company went bankrupt and in the area of the abandoned quarry you can observe the wild.

Marbles and marbled limestones, as well as attractive limestones are found in many places in the region of Kyustendil. In the Konyavska Mountain (Garbino - Skakavitsa) there is a large quarry for limestone crusher for paving railway lines, but in the mountain there are also bundles of detritus limestone with opportunities for cutting slabs with fossil inclusions (buffaloes).

Coal, oil and petroleum (continued in Part II)

Kyustendil region is a typical coal region and coal and other organic products will be discussed briefly in this book. Peatlands give information about the past, present and future of the area.

Katrishte deposit. The coal was discovered during the exploration of the gold-bearing deposits of the Struma River in 1974. The project was carried out by Assoc. Prof. Bakalov (MGU). It was studied by the state and provided to a private company, which seized the coal and provided it to the Bobov Dol TPP at reduced prices, which bankrupted the Nikolichevtsi mine (reserves for 50 years) and created serious problems for the Bobov Dol mine (reserves for 500 years). The spent quarry at Katrishte was resold several times and is now owned to a company in Scotland. The mine does not work. In order not to fill the trench with water, a drainage trench was created across the Struma River, which trench dehydrates the apple orchards on the left bank of the Struma River from Katrishte to Konyavo (Fig. 13). The excavated earth mass (marls) is a "mountain" and it will not be returned in the trench soon, because it costs about BGN 60 million. It obstructs the low warm air masses from the south, coming from the Mediterranean Sea along the Struma River and in spring time the fruit plantations typical for the region - cherries often freeze.

On the other hand, the marls from the embankment at Katrishte, as well as the embankment at the abandoned mine Nikolichevtsi, are potentially suitable for the production of construction ceramics (bricks and tiles). It is possible that they will also be used in cement production. It is necessary to carry out specialized studies in this direction and assess whether these materials are suitable for direct use or whether they need to be modified (adding necessary components).

Smolychano deposit. In the valley "Svinarniko", near the village of Smolychano, Yordan Zahariev describes (Zahariev, 1949) coal mine: "Three partners, with a permit for search and exploitation of mines, in the summer of 1933 began to dig and by the middle of 1935 they managed to carve four galleries, an average of 12 meters in length, and extracted about 250 tons of coal, which, according to the analysis, had the following composition: 11.5% tar, 73.0% semi-coke, 3.5% water, 9.5% light gas and 0.5% ash. They burn with smoke and the smell of asphalt; heat – 5000 calories, almost no ash. In the village of Nedelkova Grashtitsa they were used for baking bricks, but due to the high temperature that the coal developed, the bricks glazed and became a bar. So then they began to mix the coal with sand. For them, Prof. Georgi Bonchev says that they are without pyrite content, in a closed barrel they inflate, develop gases that burn in the open end of the barrel, give tar substances and leave a sintered mass with a metal surface - coke. However, because the coal seam consists of one or two layers of insignificant thickness, they are of no practical importance.

It is precisely because of this circumstance, it seems, that their exploitation in 1935 stopped, among other things, because of the lack of a road for their removal, which, however (only 9 kilometres to the Vaksevo-Kyustendil road), would have been made by the partners if the mine had been profitable.

Perhaps the name of the village – Smolychano – should be associated with the coal, which the locals call "resin stones". Or because of the black layer that has resin dragged onto the rock of the waterfall and painted it; The villagers think that this "resin" comes from those coal, the location of which is higher above the waterfall.

Coal indications

Coal, at the same time, was mined on the left bank of the Bistritsa River, the village of Sovolyano. Coal layers with a good view were observed in the area between villages Gorno and Dolno Uyno, as well as in the area of Korten - Treklyano.

Oil perspective

In an article by Petar Selnicki it is reported that in the spring of 1958, on the hill near Shiyachka mahala in the village of Stradalovo, a drilling was drilled by the Geological Survey – Sofia for oil prospecting. At the same time, oil was discovered at Dolni Dabnik and the well was withdrawn, although it had only been drilled 300 meters out of the planned 700 meters and the project included the drilling of several wells. He also reports that during a conversation with his 88-year-old compatriot Boris Hristov, he learned that in 1942, two German geologists were looking for oil in the area of Pelatikovo. In the land of Pelatikovo and Searchno there are stone tablets soaked in oil, which the local population calls "burning stones".

This information corresponds to studies of the area for oil content in 1938 by the Bulgarian geologists Konstantinov and Cohen (Fig. 13). The Germans (Canaris) were probably informed about the prospects of the area and in 1942 they made revision rounds of Pijanec.

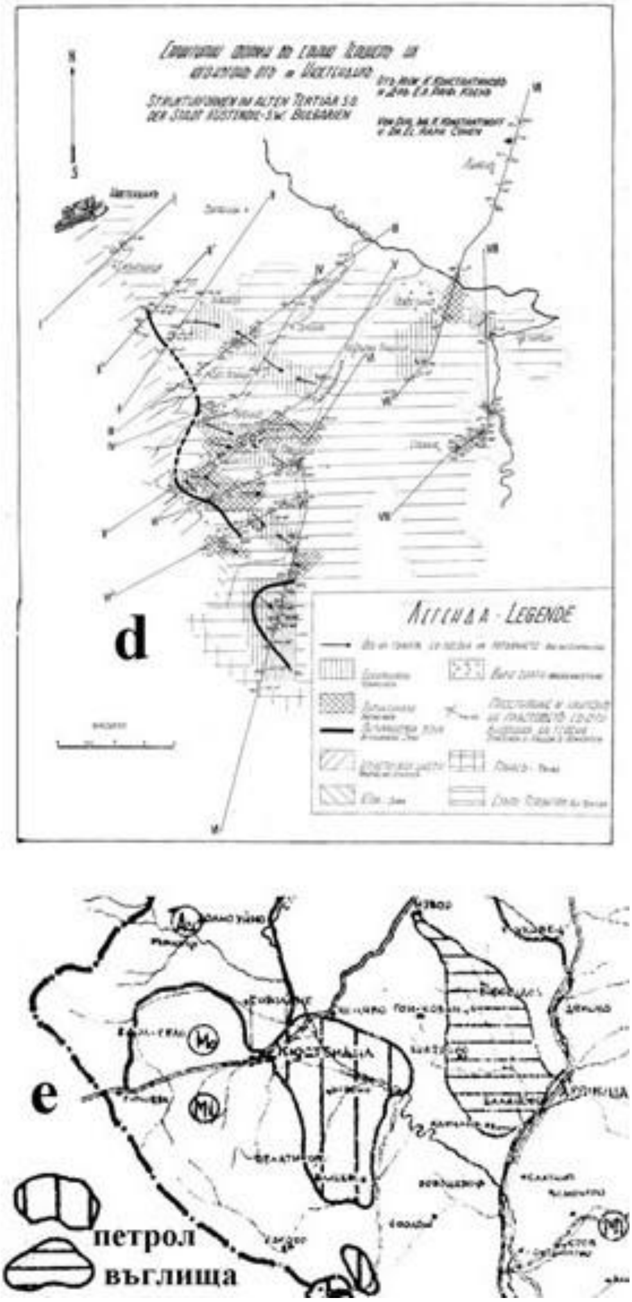


Fig. 16.Archive map for Katrishte coal deposit by Cohen's Records of the Region's Oil Supply: d-1941; e-1947 (Konstantinov & Cohen, 1941; Cohen, 1946).

After detailed studies and mapping of the territory, Elizar Cohen and Konstantinov found that there were indications of oil fields in the Piyanets region:

1. There is a bituminous zone of several meters to several tens of meters of bituminous shale, asphalt limestones and sandstones.

2. Presence of asphalt in cracks and intragular in limestones and sandstones, as well as tar-like semi-liquid soluble bitumen.

3. Presence of reservoir rocks – thick-layered, too porous sandstones in the lower parts of the old Tertiary.

4. Presence of clay layers in alternation with thin-layer sandstones occupying the upper sections of the old Tertiary, which will serve as a protective cover for oil.

5. The power of the old Tertiary is over 1000 meters and has suitable facial features.

6. Presence of anticlines and faults suitable for oil accumulation.

The expected depth of the oil deposits is from 500 to 1000 meters (Selnicki, 2008; Konstantinov & Cohen, 1941; Cohen, 1946).

In 1987, in the land of the village of Eremia, "Rare Metals" - Buhovo carried out numerous drillings with a depth of up to 400 meters to search for uranium ores. The results of this activity, as well as the overall work of Buhovo, were secret.

After the democratic changes, the enterprise "Rare Metals" - Buhovo was liquidated, the entire archive was filmed and sold to an Irish company, after which it was taken to the National Geofund for use for a fee. There is also a working archive, which is kept in the basement of the Earth and Man Museum - Sofia. It is assumed that the data from the Pijanec region are in this museum.

The liquidation of "Rare Metals" - Buhovo is a separate topic, but it should be known that with Order No. 22/23. 09. 1991 of the Council of Ministers on the basis of the Law on the Formation of Sole Proprietorship Companies with State Property, State Fund "Rare Metals" was liquidated and in its place from 01. 10. In 1991, 17 commercial companies were established: 1. "Rare Metals" Ltd. – Sofia. Buhovo; 2. "Trakia RM" EOOD – Momino Selo village; 3. "Underground Construction" Ltd. – Sofia. Buhovo; 4. "Geostroykomplekt" Ltd. – Sofia. Sliven; 5. "Georesource" EOOD – Sofia. Simitli; 6.

"Balkan" EOOD – Tserovo village; 7. "Zlata" Ltd. – Sofia. Thorn; 8. "Zvezda" EOOD – Eleshnitsa village; 9. "Georedmet" Ltd. – Sofia. Buhovo; 10. "Redmet" Ltd. – Sofia. Buhovo; 11. "DIAL" Ltd. – Sofia. Buhovo; 12. "Minmashremont" EOOD - quarter. Yana, Sofia; 13. "CRSB - Yana" EOOD - Kv. Jana; 14. "ATP – Buhovo" – Sofia; Buhovo; 15. "MTS - RM" EOOD - kv. Yana – Sofia; 16. "Holiday Complex – RM" EOOD – Sofia. Buhovo; 17. "SMP - Buhovo" - Sofia. Buhovo, after which by Decree of the Council of Ministers No. 163 of August 20, 1992 the uranium mining activity in Bulgaria was terminated in the following companies: "Rare Metals" Ltd. – Sofia. Buhovo; "Trakia RM" Ltd. – Momino Selo village; "Underground Construction" Ltd. – Sofia. Buhovo; "Geostroykomplekt" Ltd. – Sofia. Sliven; "Georesurs" Ltd. – Sofia. Simitli; "Balkan" Ltd. – Tserovo village; "Zlata" Ltd. – Sofia. Thorn; "Zvezda" Ltd. – Eleshnitsa village; "Georedmet" Ltd. – Sofia. Buhovo; "Redmet" Ltd. – Sofia. Buhovo; "DIAL" Ltd. – Sofia. Buhovo.

According to Prof. Balinov (MGU-Sofia), there were oil deposits in the Kyustendil region, but they were destroyed by the intense tectonics of the region, described by Ekim Bonchev as the Kraishtid tectonic zone. In recent years, there has been a change in the ideas about the geological structure of the territory. New tectonic elements and enormous waves have been introduced, which deeply overlap rock structures unaffected by tectonics. These ideas should be verified with deep structural drilling and it is possible that the manifestations of bitumen in Pijanets will turn out to be manifestations of productive oil fields.

Structural drilling is expensive and is not a priority for "free economic initiative". They do not bring profit, but knowledge and information and the information is money. Only the state and/or the municipality can make such risky, large-volume capital investments.

Soils

Figure 6 shows the soils studied in the Kyustendil region using the "secondary geochemical halo" method (a); pronounced anomalies in lead, zinc and copper (c) and a Fourier model of the distribution of soils contaminated with lead, zinc and copper in the Kyustendil region (c). In the area of the Kamenishko depression, Eolic (wind) pollution with toxic metals (d) from the zink-lead mining landfills near Gyueshevo was found. areas with real pollution (Vitov, 1999a,b, 2000; Vitov & Yamakov, 1996).

In North Macedonia, in this way, a systematic and periodic sampling of the entire soil cover is organized along a 1x1 km network with densifications in areas with high values (anomalies). This approach allows to control the change in soil composition due to natural processes and man-made pollution and to make responsible decisions in land use.

Especially relevant is the problem with highways and first-class roads – a linear pollutant with high intensity and a wide range of impacts (noise, dust, heavy metals, emissions from wear of car tires and asphalt, oil droplets, fuel mixture, carbon dioxide, carbon monoxide, nitrogen oxides, household and man-made waste). The fight against icing in winter with lye and salt, as well as the banquet coatings with rock species alien to the region, lead to saturation of the territory with components foreign to the region and environmental problems.

Dynamic changes in the environment (seasonal, annual, century-old) can be controlled with continuous monitoring. The era of one-off research is long gone, and the dynamics of time and processes require real-time observations and management.

At the vicinity of the valley of Kyustendil can be indicated four main soil types – Arenic Fluvisols, Haplic Chernozems-Vertisols, Chromic Luvisols, and Cambisols (WRBSR, 2006) (Teoharov et al., 2009). All of them are distributed only in the form of small spots in the Northwestern part of the Kyustendil valley. Cambisols covers the belt from 800 m to 1900 m above sea level, and Chromic Luvisols occupy the peripheral parts of the valley and slopes up to 800 m altitude. The most common are the Arenic Fluvisols, which occupy the bottom of the Kyustendil valley and the floodplain and overflow terraces of the rivers – Struma, Dragovishtitsa, Bistritsa and Banshtitsa (Ivanchev, E., 1996).

The soil on the territory of the most orchard gardens in the area is defined as leached Chromic Luvisols (FAO-ISRIC-IUSS, 2006) (Fig. 18), as the soil pH varies from 5.0 to a depth of 0-10 cm and reaches 5.4 at a depth of 100 cm, and the humus is 0.98% at the surface and decreases to 0.40 at 100 cm, according to Zdravkova (2012). Various reference data about the soils is presented in Tables 1 to 8). Table 10 presents own results from soil studies.

Table 1 Mechanical composition of the *Chromic Luvisols* soils in Kyustendil, % (Krumov, 2014)

Depth, cm	Hygroscopic moisture	Sum >1	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	Sum <0,01
Profile 1									
0-20	1,69	0,0	20,3	21,4	21,3	16,2	3,2	37,00	37,0
20-40	1,79	1,2	20,3	18,6	23,8	11,7	7,9	36,20	36,2
40-60	2,55	3,5	28,5	11,6	17,9	7,7	5,3	38,50	38,5
60-80	2,22	1,2	33,0	14,2	16,0	7,5	4,5	35,60	35,6
80-100	2,55	0,0	16,1	8,8	22,0	17,1	7,2	53,10	53,1
100-120	2,62	4,1	21,3	13,3	18,1	7,2	4,5	43,20	43,2
Profile 2									
0-20	1,85	0,0	16,3	21,9	22,2	9,5	8,2	39,60	39,6
20-40	1,87	0,0	16,8	21,6	22,4	8,7	8,7	39,20	39,2
40-60	2,55	0,0	15,7	17,1	23,1	10,2	5,9	44,10	44,1
60-80	3,05	0,6	16,2	17,8	17,9	8,6	6,7	47,50	47,5
80-100	2,77	0,6	18,6	18,5	16,4	10,9	5,1	45,90	45,9
100-120	2,83	1,6	21,2	16,6	17,6	6,9	5,6	43,00	43,0

Table 2 Physical properties of the *Chromic Luvisols* soil in Kyustendil (Krumov, 2014)

Depth, cm	Vol. density, g/cm	Rel. density, g/cm^3	Total porosity, %
0-10	1,90	2,54	25,20
10-20	1,79	2,71	33,95
20-30	1,67	2,75	39,27
30-40	1,59	2,52	36,90
40-50	1,59	2,54	37,40
50-60	1,55	2,67	41,95
60-70	1,67	2,63	36,50
70-80	1,55	2,61	40,61
80-90	1,58	2,53	37,55
90-100	1,53	2,52	39,29
0-60	1,68	2,62	35,78
0-100	1,64	2,60	36,82

Table 3 Chemical characteristics of the *Chromic Luvisols* soils in Kyustendil, % (Krumov, 2014)

D epth, cm	pH/KCl	N, mg 1000 g	P_2O_5 mg/100 g	K_2O, mg 100 g	Humus, %
Profile 1					
0-20	6,1	35,87	4,1	20	1,52
20-40	6,1	37,58	3,0	15	1,48
40-60	6,0	30,74	2,6	11	1,45
60-80	5,8	27,32	2,2	8	1,37
80-100	5,8	25,62	2,1	15	1,10
100-120	5,5	14,52	1,8	11	0,96
Profile 2					
0-20	5,7	34,16	5,3	18	1,48
20-40	5,6	23,91	3,1	13	1,37
40-60	5,5	25,62	3,0	14	1,45
60-80	5,7	20,50	3,4	14	1,22
80-100	5,8	22,20	2,1	13	1,11
100-120	5,4	17,08	2,0	13	1,04

Table 4 Mechanical composition of an average profile of leached *Chromic Luvisols* (Teoharov, 2009).

Grain size	>1	1,00-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
Average,%	1,94	16,53	14,92	9,89	5,18	5,26	30,67	41,48

Table 5 General chemical properties of an average profile of leached *Chromic Luvisols* (Teoharov, 2009)

General chemical properties	Humus, %	Total Nitrogen N, %	C:N	Ca CO_3	pH (H_2O)	pH (KCl)
Average,%	0,90	0,99	7,25	12,76	5,83	2,98

Table 6 Physico-chemical properties of an average profile of leached *Chromic Luvisols* (Teoharov, 2009)

Physics-chemical properties	$T_{8,2}$ meq/100t soil	$H_{8,2}$ meq/100t soil	Al meq/100t soil	Ca meq/100t soil	Mg meq/100t soil	$H_{8,2}$ % of T8,2	Al	Ca	Mg	Degree of saturation with bases, V (%)
Average, %	29,70	2,50	0,00	21,90	7,6	7,1	0	65,6	14,5	77,7

Table 7 Average mechanical composition (microscopically determined) of the *Chromic Luvisols* soils in Kyustendil, Vol. % (Sotirov, 2024).

Depth, cm	>2 mm	1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,005 mm
0-70 cm, summarized sample, %	1,0	18,2	20,1	18,6	21,3	4,6	16,2

Table 8. Mineral composition of the investigated soils by fraction >2<0.05 mm (Sotirov, 2024).

Fraction	Mineral composition	Roundness	Sphericity	Surface
>2 mm- <0.05 mm	Quartz – Q; Magnetite -Mt, Calcite – Cc; Gneisses – G; Feldspar – Fs; Muscovite – Ms; Biotite – Bi , limestone, feldspar, limonite, hematite, calcite, apatite, olivine, gneiss (with muscovite, biotite and pyrite) and Cl-slate lithites	0.1; 9.3; 0.5; 0.7 very angular, semi-angular, angular – to semi-rounded	0.3; 0.5; 0.7; 0.9 from high-to low	hatching, dullness, clarity, scraps, strokes

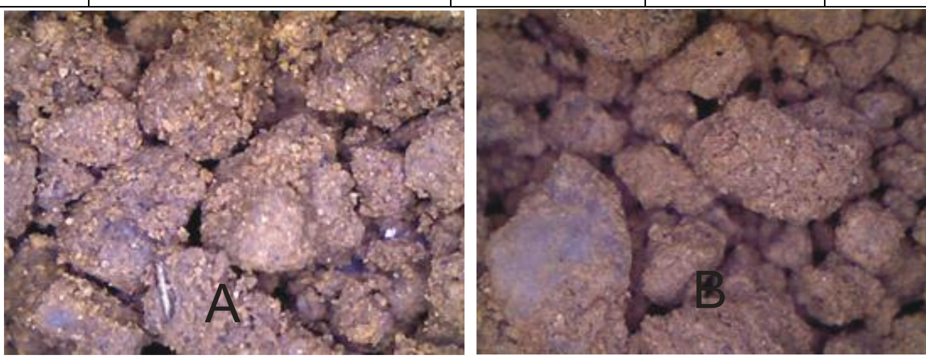


Fig. 17 Microscopic view of the soil and its minerals (air, reflective white light, x200, digital microscopy); A, B) Mineral grains - mainly quartz <1 mm, covered with clay minerals, mainly montmorillonite and dust fraction <0,001 in different ratios (carbonate $CaCO_3$) (Sotirov, 2024).

Microbiology of the *Chromic Luvisols* soil in Kyustendil

The fewest microorganisms in the soil are under the conditions of the standard technology of growing the apple. The application of irrigation mode 100% ET and fertilization with 24 kg/acre as Nitrogen /N/ do not provide a suitable environment for microorganisms, since poor soil aeration is a limiting factor for the development of the studied microflora. The correlation between the amounts of microorganisms with the fertilizer and irrigation norm is strong negative.

Standard technology – /control/ includes: fertilization - 24 kg/acre N, drip irrigation - 100% ET. Soil surface - one mechanical treatment in the spring, treatment with a soil-acting herbicide and a foliar-acting herbicide in the summer. Forming - free spindle with 5 - 6 skeletal branches. Crop protection - conventional. (Taseva, Zdravkova, 2016) and (Todorova, Zdravkova, 2018) (Table 9).

Table 9. Soil microflora under standard apple growing technology, CFU/g abs. dry soil A - cellulose degrading microorganisms; B - microscopic fungi; C – actinomycetes; D - ammonifying bacteria; E – bacteria using mineral nitrogen

	Depth, cm									
	0-20					20-40				
Standard technology	A 10^4	B 10^5	C 10^6	D 10^6	E 10^7	A 10^4	B 10^5	C 106	D 10^6	E 10^7
Spring	7,3	2,23	0,33	0,7	0,48	5,8	1,95	0,1	1,55	0,23
Summer	5,3	2,53	1,23	1,58	0,75	9,5	1,6	1,2	2,28	0,62
Autumn	11,8	3,38	0,2	1,48	0,16	6,8	1,3	0,28	1,23	0,18

Table 10 Summarized results from the measurements of the agroecological and agrotechnological parameters of the *Chromic Luvisols* soils – distilled water extract and precipitations of the studied area (Sotirov, 2025).

Measured Parameter,	Radiation background, µSv/h	Radiation, µSv/h	Temperature, °C	pH, Total Acidity	Conductivity (EC), mS/cm	Total Dissolved Solids (TDS), ppm	Salt, ppm	Specific Gravity (SG),	Redox-potential (Eh), mV	Dissiolved O_2, %
Soil	0,16	0,21	7,00	5,50-6,50	140,00	70,00	68,00	1,000	84,00	12,10
Rain 10 l/sq.m	0,16	0,19	8,00	6,93	22,00	16,00	20,00	0,999	243,00	13,80
Measured Parameter	Calcio, mg/l	Nitrate NO_2^-, mg/l	Nitrite NO_3^-, mg/l	Arsenic (As), mg/l	Lead (Pb), mg/l	Manganese (Mn), mg/l	Zink (Zn), mg/l	Hardness $CaCO_3$, mg/l	Total Alkalinity, mg/l	Cyanuric Acid (CYA), mg/l
Soil	49,00	<1	<1	<0,02	<0,02	n.d.	n.d.	33,0	115,0	12,00

								0	0	
Rain 10 l/sq.m	<1	<1	<1	<0,02	<0,02	<0,02	<0,02	<5	17,00	11,00
Measured Parameter	Free Copper (Cu), mg/l	Total Copper (Cu), mg/l	Combined Copper (Cu), mg/l	Iron (Fe), mg/l	Free Chlorine (Cl) mg/l	Total Chlorine (Cl), mg/l	Combined Chlorine (Cl), mg/l	Free Bromine (Br), mg/l	Fluoride, (Fl), mg/l	Iodine (I), mg/l
Soil	0,05	<0,02	<0,02	0,04	0,05	<0,05	<0,02	<0,02	<0,02	<0,02
Rain 10 l/sq.m	0,05	<0,02	<0,02	<0,02	0,09	0,08	<0,02	<0,02	<0,02	<0,02

Mineral waters

The mineral waters in the Kyustendil region are widespread. There are 5 known thermal springs (>18°C) and 5 cold springs. The bath in the town of Kyustendil was very popular and the statistics reflect the number of baths by year and the revenues of the municipality from these baths (Table 2).

In the Kyustendil hydrothermal system there are five deposits of mineral waters in different geological formations. The areas of feeding and drainage of the mineral waters have been determined, as well as the exact location of the main water sources – captive springs and boreholes. A map of the deposits has been prepared as a basis for a detailed assessment of the resources and sanitary protection zones of the individual deposits. Hot mineral springs have different water composition, temperature and genesis. In general, they are of the crack-pore type and form a system with deep circulation, high temperature (73° in Kyustendil) and low mineralization (Berov & Penchev, 2014; Radoslavov, 1933).

According to local people, it can be assumed that there are mineral waters in the valley of the Eleshnitsa River (Gorno Rakovo, Chetirtsi) and in the Kamenishka Depression (Lehchanska mahala).

The Kyustendil mineral waters are associated with the Paleogene volcanism and the Osogovo granite intrusion. Around Rila Mountain there is another ring of mineral springs (Momina Banya, Sapareva Banya, Banya-Razlog, Velingrad, etc.) related to the orogeny in the region.

Mineral waters are a priceless treasure with their variety and healing properties. The Roman legions after a campaign necessarily underwent a cycle of balneo-sanatorium treatment (in today's terminology) in order to preserve their combat capability. In Pautalia there was built a large Asklepion for the Roman Empire - five temples for treatment and rehabilitation. Remains of this temple were discovered in the area of the summer theater of Kyustendil, in close proximity to the mineral spring.

The fate of the mineral spring in village of Nevestino is a typical story. A young man escaped from socialism to the United States and returned after the democratic changes. He presented bank guarantees from well-known banks and bought the mineral spring and the factory to it. Together with the then Minister of Environment and Water, they found a fountain with mineral water at the bridge in the village. He began to produce mineral water in plastic packaging and sell it. The first batch – of the US army in Iraq. He was refused on the grounds that the US Army only drinks water from Iceland. The second batch was bought by the peacekeeping forces in Kosovo. The third batch was paid for by the same military, but the purchase of more water was refused because it contained algae (algae) and drinking it led to an upset. The businessman is suing the state for lost profits and won the case with the amount of 12 million BGN, without having sold a single liter of water in Bulgaria. At the moment, the water from the spring flows into the Struma River, the factory building is used as a depot of documents from the archive of the National Social Security Institute. The fountain next to the bridge is closed with a homemade sign that the water is not suitable for drinking.

Without a doubt, the state takes care of its businessmen. At that time, by order of the Minister, a regulation was issued, which closed all public fountains and fountains. Even the fountains in the train stations and city squares. The idea is, already as a cultured people, to drink water from plastic bottles. Then it turned out that these bottles are more harmful to health and nature, even to the entire planet, and the water in them is not "table", but from the tap.

River waters

The biggest river in the region is the Struma River. The Struma River springs from 2246 m above sea level, closely to the peak Tcherni Vrah (2290 m) of the Vitosha Mountain, near to the capital city of Sofia, Bulgaria. The length of the river is 415 km, from which 290 km are situated in Bulgaria and the rest 125 km are situated in Greece, where the river flows into the Mediterranean Sea (Fig.18). By this way it might appear a cross-border pollutant. On the territory of Kyustendil municipality, the river has four big right situated feeders: Dragovishtitsa River, Bistritsa River, Novoselska River, and Banshtitsa

River. Dragovishtitsa River which length is 70 km, it is a right tributary to the Struma River and flows through Southeastern Serbia (45 km) and Western Bulgaria (25 km). Bistritsa River has 51 km length. Banshtitsa River is 22 km long, and Novoselska River is 25 km long. All four feeders spring at the cross-border area between Bulgaria and neighbor countries Serbia and North Macedonia. Information about the topic is published only by our team (Tables 11 and 12) (Sotirov, 2024; Sotirov et al., 2014, 2013).

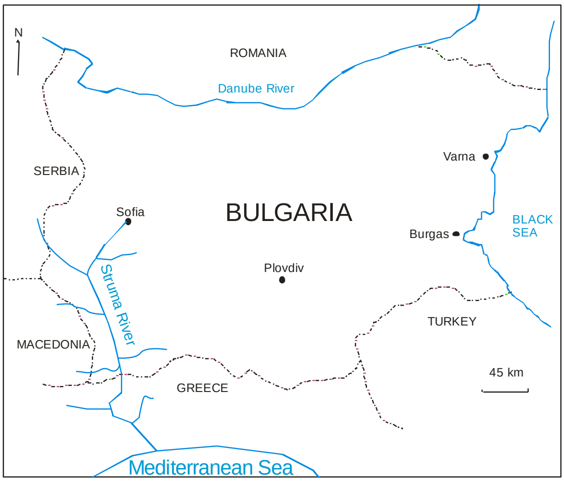


Fig. 18. Location of the Struma River and its tributaries. Source: Own drawing

Environmental situation of the river waters in Kyustendil region:

1. Dragovishtitsa River is not contaminated. Water is relatively clean and because of this reason the fish species *Salmo trutta fario* is widely spread (Tables 11,12,13,14).

2. Novoselska River is contaminated with Cyanuric acid, copper and high alkalinity around the illegal dumpsites. No fish species in the river.

3. Banshtitsa River is relatively pure with high hardness ($CaCO_3$) and salinity, which could be explained with the drought of the river in the end of the summer season. There are observed some fish species. Biological species Branchiopoda disappears at places of illegal landfills at about 300 m after them.

4. Bistritsa River is contaminated with washing chemicals and has high alkalinity and because of this reason foaming can be observed at her confluence into the Struma River. No fish species observed.

5. Struma River and its feeding rivers have increased conductivity (high salt/mineral content) which probably is a natural process because of the low level of rivers their salinity is increased.

6. The temperature of the water of Banshtitsa River is abnormally high because of the high amount of hot mineral water which inflow into the river.

7. The disinfectants and the detergents in Struma River have high concentrations, above 8 mg/l. Because of this reason the fish species *Salmo trutta fario* probably is rare in this river.

8. Total alkalinity is high, which might be explained with the low level of rivers and the fact that it passes through carbonate rocks and dumping of construction waste at the illegal landfills along the rivers.

9. The copper in the water of Bistritsa and Novoselska rivers is high, which is danger for systematic irrigation of agricultural lands and cattle-breeding.

Table 11 Environmental Chemistry of Struma River and its right tributaries

River	Acidity pH	Electroconductivity EC, mS/cm	Total Dissolved Solids TDS, ppm	Nitrite NO_3, mg/l	Nitrate NO_2, mg/l	Total Cl, mg/l	Cianuric acid CYS mg/l	Total alcalinity $CaCO_3$, mg/l	Total Cu, mg/l	Iron Fe, mg/l
Struma River	7.20	5.70	115	10	0	0	4	178	0.14	0
Treklyanska River	7.92	4.20	93	0	0	0	2	230	0.21	0.04
Dragovishtitsa River	8.43	3.63	65	0	1	0.08	6	242	0.2	0.02
Bistritsa River	8.26	3.60	62	0	0	0	12	198	0.27	0
Banshtitsa River	6.69	3.30	78	50	10	0.1	7	178	0.19	0.04
Novoselska River	7.55	3.20	79	10	0	0.10	16	160	0.32	0.12

Eleshnitsa River	7.96	3.60	72	0	0	0.00	3	162	0.11	0
Strumeshnitsa River	7.58	4.02	95	25	10	0.00	4	253	0.11	0.03

Table 12 Environmental parameters and bio-indicators of Struma River and its right tributaries

River	Microplastics, %	Radiation background µSv/h	Radiation water, µSv/h	Radiation of sediment, µSv/h	Coliforms	*Salmo trutta*, levels 0-10	Zoo-bentos leves 0-10
Struma River	3	0.20	0.16	0.16	3850	5	7
Treklyanska River	1	0.10	0.24	0.27	125	10	10
Dragovishtitsa River	0	0.24	0.20	0.20	78	10	10
Bistritsa River	1	0.16	0.20	0.16	115	0	5
Banshtitsa River	20	0.18	0.20	0.24	3000	0	1
Novoselska River	2	0.20	0.20	0.16	220	0	5
Eleshnitsa River	0	0.20	0.20	0.20	83	10	10
Strumeshnitsa River	0	0.20	0.12	0.20	132	5	8

10. Anthropogenic micro-detritus is widely spread in the sediments and soils and measures for this contamination must be taken.

11. Quality of the soils along and water of the studied rivers influence directly on the quality of the crops, livestock, and produced food.

12. Through using of microscope with fluorescence (blue) light it was established polyethilene micro-detritus in soils, sediments. Polyethilene fragments may become a part of the food chain and might cause strangling of the animals, occlusion of the digestive tract, trauma of the internal organs, necrotic and inflammation of the intestines, intoxication of the man and animals. Presence of the anthropogenic micro-detritus might become poor the soil and change the soils structure. Pure plastics have low toxicity due to their insolubility in water and because they are biochemically inert, due to a large molecular weight. Plastic products contain a variety of additives, some of which can be toxic. For example, plasticizers like adipates and phthalates are often added to brittle plastics like polyvinyl chloride to make them pliable enough for use in food packaging.

Table 13 Inventory of the minerals from the river sands in Kyustendil district in alphabetical order and number of samples in which they were found.

№	Mineral	Number samples	№	Mineral	Number samples	№	Mineral	Number samples
1	Anatase	19	2	Anglesite	10	3	Andalusite	3
4	Apatite	396	5	Arsenopyrite	12	6	Barite	2125
7	Bismutite	342	8	Vanadinite	2	9	Wolframite	7
10	Wolfenite	40	11	Galena	426	12	Granate	537
13	Epidotus	328	14	Gold	1467	15	Ilmenite	1807
16	Cussiterite	8	17	Kyanite	1156	18	Columbite	3
19	Corundum	75	20	Xenotime	432	21	Leucoxen	16
22	Limonite	26	23	Magnetite	278	24	Malachite	35
25	Marcasite	53	26	Martit	372	27	Cupper	2
28	Molybdenite	37	29	Monazite	2484	30	Lead	140
31	Ortit	359	32	Pyrite	2049	33	Pyrolusite	118

34	Pyromorphite	124	35	Rutile	1861	36	Ilmenite	1
37	Stavrolite	4	38	Sphalerite	37	39	Titanite	1974
40	Titanium	545	41	Thorite	357	42	Tourmaline	470
43	Fluorite	17	44	Chalcopyrite	24	45	Hematite	330
46	Chromite	186	47	Cerussite	123	48	Cynabarite	206
49	Zircon	3273	50	Scheelite	824	51	Spinel	23

Number of samples 9255; Number of minerals 51. Source Own data

Table 14 Use of mineral waters in Kyustendil for the period 1927-1932 (Berov & Penchev, 2014; Radoslavov, 1933).

year	1927	1928	1929	1930	1931	1932
Number of baths	261741	286090	293392	300858	266074	261063
Revenue (BGN)	1667554	1873074	2034124	2095257	1894240	1780932

6 Conclusion

Kyustendil Municipality and Minerals in Kyustendil Region in 1980, Geological Surveys – Sofia was commissioned by the Committee of Geology to build on the territory of Kyustendil a Research Centre, a branch of the Institute of Minerals – Sofia with a laboratory block, an administrative building and family household buildings. 50 million euros were allocated. leva, an architectural project was prepared, a place for construction was determined and the project failed due to the refusal of the Municipality of Kyustendil to provide for the construction. On the site of this Institute, the ruins of another unrealized project are now located - "Home of the Single Mother" (opposite the hospital on the road to Hisarlaka).

In 1984, Professor Petko Popov, Dean of the Faculty of Geological Exploration of the University of Mining and Geology – Sofia, proposed a project for the construction of a branch of the University in the city of Kyustendil with the Faculty of minerals, laboratory block, administrative building and housing. The project is not implemented through the fault of the Municipality of Kyustendil. In an attempt to arouse interest and to see the state of the problem, in 1995 the author organized a conference at the Scientific and

Technical Union Kyustendil, but this conference was not reflected in the local press, did not interest the banks in Kyustendil for sponsorship, and there was no trace of the efforts of a galaxy of prominent specialists. A large part of these patriotic geologists are no longer among the living. The conference ended with a conclusion about the structurally determining role of minerals for the development of the economy of the Kyustendil region and Bulgaria. After that, the government closed the Geology Committee and destroyed the mining and geological exploration industry in Bulgaria.

The words geology, geologist, mining, mining engineer, minerals and mineral resources have become dirty words both literally and figuratively. Unlike European countries, where students study geology along with biology, in Bulgaria geology is as uncomfortable as the Orthodox Christian religion. Geologists fell out of favor with entire generations of the most erudite and educated specialists in the country, either emigrated or lived their lives as cleaners and cooks, ridiculed and mocked by the rest of the "specialists". Municipal and state rulers never understood that money, economic prosperity, sovereignty, independence, military and energy independence, even ecology come from the earth. If there is no exploration, monitoring and good management of land resources – there is no state.

Recommendations

Research and management of fossil resources in the Kyustendil region.

The main resource of the municipality of Kyustendil is minerals, and there is no staff for a "municipal geologist". Obviously, the Municipality of Kyustendil should explore the natural resources itself and manage them in the interest of society, here and now. Every year, the University of Mining and Geology graduates skilled personnel for this work. They work abroad or, at best, in Bulgaria for companies such as the Canadian Dundee, and most often they are unemployed or retrained and there is no municipal structure to take over these valuable workers.

The first step in this direction is the creation of a body (structure) at the Municipality (or the Regional Historical Museum) to collect and preserve the available geological information about the region (copies of geological reports in the National Geofund, references from the State Archives, articles from scientific journals, reports, monographs, etc.).

The second function of this unit is to process data and update information to the current state of science geology, changes in mining and processing technologies, as well as the mineral market.

The third function is the creation of policy and management of resources – new searches and explorations, mining concessions, factories for processing to market goods (precious stones, metals, rock cladding materials, raw materials for chemistry).

The fourth function should be the study of the historical heritage and its preservation with the exhibition of ancient mines, equipment, materials and historical information, the study of material facts (artifacts) from archaeological excavations - chemical and mineralogical analysis of ceramics, rock material, metals and alloys, paints, absolute age, etc.

The fifth function is education and cultural tourism – an exposition with fossils, minerals, rocks, ores, photos, geological maps, articles and reviews of various sites, routes for lapidaries (collection of collection samples), trade in valuable minerals from the region (jaspers, feldspar crystals, river gold, etc.), circle work with high school students, consulting services for businessmen.

Sixth – the most important function of the described structure is observation of the use of available resources – competent control of the exploitation and protection of nature.

The multidirectionality of the activities is the result of the complex nature of the site – the underground resources of the Kyustendil Municipality, economy, history, education and tourism.

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7. SOIL AND WATER AROUND FORMER OSOGOVO LEAD-ZINC ORE MINE (Dimitrov et al. 2004)

Introduction.

Water status. The water conditions of the rivers Lebnitsa, Bistritsa and Kriva reka satisfy the conditions for waterways II category. The concentrations of lead, cadmium, nitrogenous nitrite, manganese, cyanides, and copper in the water are higher than the background of the environment. The concentrations of lead, cadmium, manganese, and insoluble chemicals in many samples exceed the permissible breaking concentrations (PBC).

Air status. The present study established that the dust contamination in the areas around the ore-enrichment plant and landfill near to Gyueshevo village-Bulgaria is high. The sampling was done in windy weather. Dusty winds are frequently met phenomenon in the studied area. The composition of the dust is the same as the ore and the ore waste. The amount of the dust in the atmosphere during non-windy weather is below the permissible breaking concentrations (PBC) in the above-mentioned areas as well as in the area of ore-enrichment plant “Toranitsa”-Macedonia.

Soil status. The soils of the studied areas have concentrations of lead and zinc, which exceed the permissible breaking concentrations for heavy metals (PBC). The soils around the ore-enrichment plan and purifying plant for landfill cyclic water supply, situated at the valley of river Lebnitsa are characterized by concentrations of heavy metals, which exceed the PBC. The two-kilometer alluvial zone near to the landfill, situated at the valley of river Kriva reka is highly contaminated. The concentration of the copper is below the PBC in soils with every kind of acidity. Some areas are contaminated with cadmium.

The areas around the ore-enrichment plants and landfills are seriously contaminated. The established contamination with lead and zinc is definitely a result from the activity of the lead-zinc ore mines in these areas. However, we should mark that the natural litho-geochemical background of the studied hazardous elements is high in the Osogovo Mountain.

Material and methods

The water samples were taken three times during the autumn-winter period of second low-water level, during the period of spring high-water level and during the summer low-water level. The samples were summarized as they were taken during a five-hour period at one-hour intervals. The quantity of each sample was 1l.

Measurement of the temperature of the air and water was done, parallel with the sampling. Samples from the air were taken during different seasons and places – closely to the ore-mining fields, ore-enrichment plants, landfills, and the closest living places. The aspiration method for air sampling was used for determination of the dust concentration with an exposition of 120 min. /Bulgarian State Standard - BDS-17.2.4.20-83/. The relative error margin in the analysis method used is within the limits 3-5%.

Eighteen soil samples were taken from the Bulgarian part and 18 from the Macedonian part of the Osogovo Mountain from the A soil horizon. The samples from non-agricultural lands were taken from 0-10 cm deepness, but the samples from agricultural lands were taken from deepness 0-20/25 cm. The laboratory analyses for heavy metals were done, according to the Bulgarian State Standard - BDS 17.4.4.02-80. The samples are treated with HF and HClO4 and the measurements of the element concentrations were done with an atomic-absorption spectrometer Perkin-Elmer 4100.

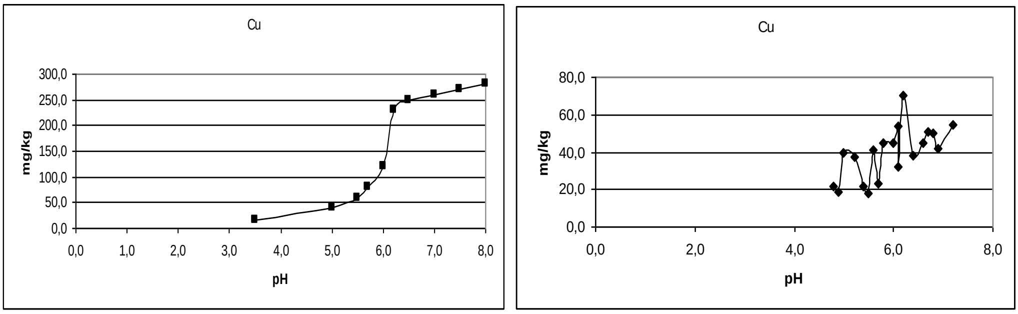
Results and discussion

Water conditions during the study period. The water of the rivers Lebnitsa, Bistritsa and Kriva reka satisfy the conditions for waterways II category. The concentrations of lead, cadmium, nitrogenous nitrite, manganese, cyanides, and copper in the water are higher than the background of the environment. The concentrations of lead, cadmium, manganese, and insoluble chemicals in many samples exceed the permissible breaking concentrations (PBC) (Table 1).

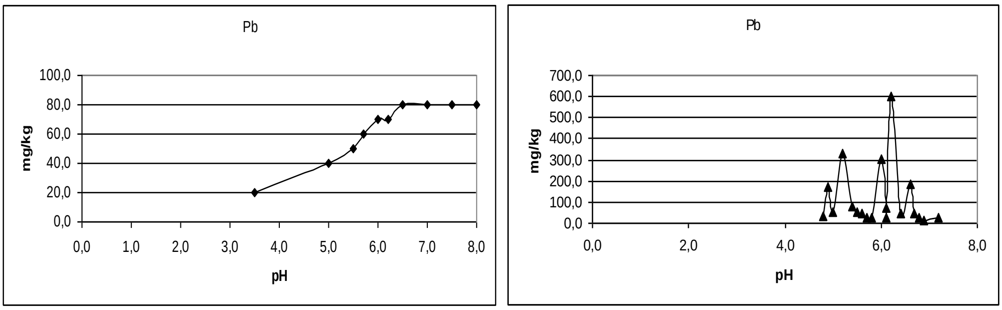
Table 1. Results from the physics-chemical analyses of water from the mining areas in Osogovo Mountain (mg/l); n.d.-no data.

INDICATORS	Permissible concentrations		December 1999 Bulgaria						August 2000 Bulgaria					
	II categ.	III categ.	River Bistritsa beneath Ruen Mine	River Bistritsa after River Lebnitsa flow	River Bistritsa at Garlyano village	River Lebni-tsa beneath Ruen Plant	Well depth 7 m near River Lebni-tsa	River Lebni-tsa near to the landfill	River Bistritsa beneath Ruen Mine	River Bistritsa after River Lebnitsa flow	River Bistri-tsa at Garlya-no village	River Lebni-tsa beneath Ruen Plant	Well depth 7 m near River Lebni-tsa	River Lebni-tsa near to the landfill
Active reaction pH	6,0-8,5	6,0-9,0	7,6	8	7	7,8	7,1	7,8	7,8	7,3	7,3	7,6	6,9	7,6
Soluble O2	>4	>2	7,1	7,4	7,3	7,4	6,4	6,8	6,8	7,6	8,2	7,7	8,2	8,6
BPC component 5	15	25	5,5	4,2	4,9	6,3	4,9	4,9	2,4	2,7	2,8	1,9	3	3,3
Oxidity (perm.)	30	40	1,12	0,88	1,12	1,52	0,8	1,6	0,88	1,36	2,32	2	1,12	2,08
HPC (bio-chromatic)	70	100	40	20	30	70	20	60	30	20	30	10	30	20
Soluble chemicals	1000	1500	432	64,4	70	109,6	135,4	140,4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Insolub. chemicals	50	100	20	10	10	10	20	10	20	10	10	20	50	20
Chlorine ions	300	400	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	4	7	5	15	12	11
Sulphate ions	300	400	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	30	5	20	150	45	130
Nitrogen (ammonium)	2	5	0,03	0,01	0,02	0,03	0,01	0,01	0,02	0,01	0,012	0,01	0,014	0,01
Nitrogenous nitrite	0,04	0,06	0,01	0,001	0,002	0,005	0,005	0,001	0,001	0,001	0,01	0,12	0,008	0,04
Nitrogenous nitrate	10	20	0,6	1,18	0,8	0,8	1,7	8,16	1,34	0,3	0,56	1,66	3,29	0,54
Phosphate (PO4)	1	2	0,007	0,005	0,003	0,12	1,16	0,006	0,03	0,01	0,02	0,05	0,014	0,02
Cyanides (easily soluble)	0,05	0,1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,01	0,001	0,001	0,001	0,002	0,004
Iron (Total)	1,5	5	0,02	0,02	0,04	0,14	0,02	0,08	0,12	0,002	0,004	0,008	0,004	0,002
Manganese (Total)	0,3	0,8	0,081	0	0	0,48	0	0,34	0,05	0	0	0,04	0,01	0,15
Cadmium	0,01	0,02	0,008	0,01	0,008	0,,01	0,004	0,008	0,001	0,001	0,002	0,004	0,002	0,02
Lead	0,05	0,2	0,02	0,01	0,01	0,03	0,03	0,04	0,02	0,005	0,002	0,04	0,02	0,04
Copper	0,1	0,5	0,07	0,04	0,06	0,05	0,04	0,1	0,04	0,03	0,04	0,2	0,02	0,03
Zinc	5	10	0,1	0,22	0,24	0,48	0,24	0,15	0,008	0,08	0,01	0,08	0,08	0,06
INDICATORS	Permissible concentrations		December 1999 Macedonia						August 2000 Macedonia					

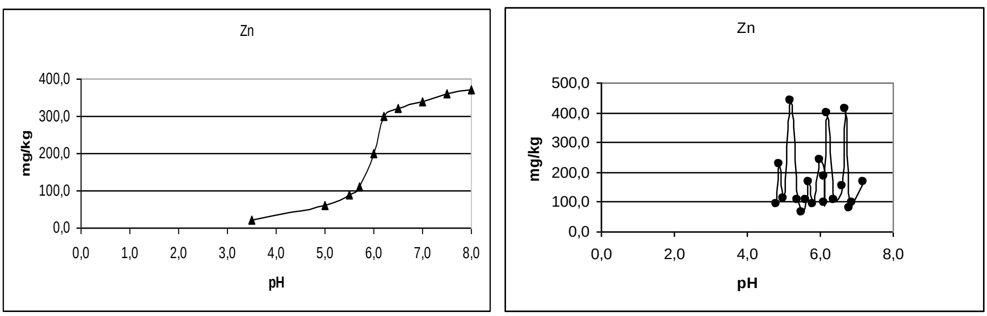
	II categ.	III categ.	River Toranitsa by the mine fields	River Banchilo before its flow in the River Torani-tsa	River Yarets before its flow in the River Torani-tsa	River Torani-tsa by the enrich-ment plant	River Krivareka 1 km from the landfill	River Krivareka at Jidlovo village	River Torani-tsa by the mine fields	River Banchilo before its flow in the River Torani-tsa	River Yarets before its flow in the River Torani-tsa	River Torani-tsa by the enrich-ment plant	River Kriva reka 1 km from the landfill	River Kriva reka at Jidlovo village
Active reaction pH	6,0-8,5	6,0-9,0	6,78	6,8	7,01	7,25	7,36	7,26	6,6	6,8	8,1	7,4	7,8	7
Soluble O2	>4	>2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	7,7	7,4	8,3	7,5	8,9	8,2
BPC component 5	15	25	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	3,1	3,4	4	4,3	3,7	3,5
Oxidity (perm.)	30	40	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	3,2	2,56	1,12	75,2	1,12	0,32
HPC (bio-chromatic)	70	100	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	60	10	10	112	10	20
Insolub. chemicals	50	100	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	20	80	50	60	20	40
Chlorine ions	300	400	7	7	27	9	7	7	7	7	6	5	4	10
Sulphate ions	300	400	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	80	60	20	70	40	30
Nitrogen (ammonium)	2	5	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,05	0,08	0,08	0,64	0,1	0,08
Nitrogenous nitrite	0,04	0,06	0,009	0,002	0,036	0,001	0,002	0,002	0,04	0,02	0,02	0,12	0,08	0,04
Nitrogenous nitrate	10	20	0,879	0,11	1,175	0,677	0,518	0,464	1,13	0,55	0,5	230	1,5	1,5
Phosphate (PO4)	1	2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,01	0,012	0,002	0,001	0,08	0,005
Cyanides (easily soluble)	0,05	0,1	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,02	0,005	0,03	0,008	0,002	0,01
Iron (Total)	1,5	5	0,159	0,017	0,044	0,076	0,018	0,021	0,04	0,002	0,001	0,001	0,002	0,008
Manganese (Total)	0,3	0,8	0,25	n.d.	n.d.	0,15	n.d.	n.d.	0,14	0,02	0,01	0,02	0,08	0,06
Cadmium	0,01	0,02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,003	0,001	0,002	0,001	0,001	0,002
Lead	0,05	0,2	0,04	0,04	0,03	0,08	0,05	0,03	0,02	0,005	0,005	0,001	0,005	0,01
Arsenic	0,05	0,2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0,001	0,001	0,002	0,003	0,001	0
Copper	0,1	0,5	0,04	n.d.	n.d.	n.d.	n.d.	n.d.	0,13	0,02	0,01	0,03	0,01	0,01
Nickel	0,2	0,5	0,04	0,02	0,02	0,02	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Zinc	5	10	0,28	0,1	0,1	0,2	0,14	0,07	0,08	0,03	0,08	0,02	0,01	0,01



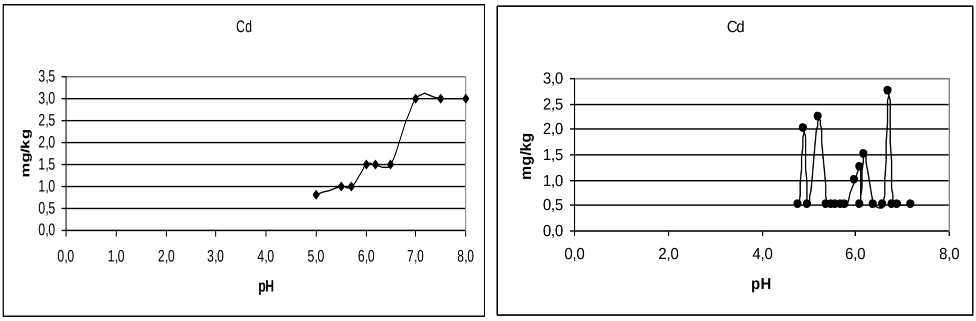
a) Permissible concentrations of Cu in soils; b) Concentrations of Cu in the studied soils.



c) Permissible concentrations of Pb in soils; d) Concentrations of Pb in the studied soils.



e) Permissible concentrations of Zn in soils; f) Concentrations of Zn in the studied soils.



g) Permissible concentrations of Cd in soils; f) Concentrations of Cd in the studied soils.

Fig. 1. Comparative diagrams between the permissible concentrations (Bulgarian State Gazette №54/1997) and the established concentrations of the studied elements in the soils.

Condition of the air. The present study established that the dust contamination in the areas around the ore-enrichment plant and landfill near to Gyueshevo village-Bulgaria is high. The sampling was done during windy weather. Dusty winds are frequently met phenomenon in the studied area. The composition of the dust is the same as the ore and the ore waste. The amount of the dust in the atmosphere during non-windy weather is below the permissible breaking concentrations (PBC) in the above-mentioned areas as well as in the area of ore-enrichment plant "Toranitsa"-Macedonia. The measured dust concentration in the Bulgarian part of Osogovo was between 187.5 µg/m3 and 897.5 µg/m3 as the PBS is 500 µg/m3, but the dust concentration in the Macedonian part varied between 151 µg/m3 and 250 µg/m3. Condition of the soil. The soils of the studied areas have concentrations of lead and zinc, which exceed the permissible breaking concentrations for heavy metals (PBC) (Fig. 1). The soils around the ore-enrichment plan and purifying plant for landfill cyclic water supply, situated at the valley of river Lebnitsa, is characterized by concentrations of heavy metals, which exceed the PBC. The two-kilometer alluvial zone near to the landfill, situated at the valley of river Kriva reka is highly contaminated. The concentration of the copper is below the PBC in soils with every kind of acidity. Some areas are contaminated with cadmium.

Conclusion

Ore-mining and ore-enrichment industry in the Osogovo Mountain, as well as the deposition of waste influence negatively on the components of the environment. The air, water and soil in the area are seriously contaminated. The concentrations of hazardous elements in many samples exceed many times the permissible breaking concentrations (PBC), which is a risk for the human health. The areas around the ore-enrichment plants and landfills are seriously contaminated. The established contamination with lead and zinc is definitely a result from the activity of the lead-zinc ore mines in that areas, like Velikov and Drenovski (1994) described copper contamination in the copper ore mining areas around the towns Zlatitsa and Pirdop. The lead causes many diseases as leukemia, kidney disorders, brain damage, early death, gastrointestinal distress, encephalopathy, and etc. The high concentrations of zinc in the environment may cause growth depression, sexual immaturity, skin lesions, immunocompetence. The cadmium causes hypertension, giddiness, vomiting, respiratory difficulties, kidney disorders, cancer, and many others. Many of the above-mentioned diseases are widespread in the studied areas. However, we should mark that the natural litho-geochemical background of the studied hazardous elements is high in the Osogovo Mountain. For an example, it is established that the coal near the Osogovo granite massive is reach of lead, zinc and cadmium as the ash contains cadmium, which concentration exceeds 22 times the permissible breaking concentrations for soil (PBC) (Kortenski, Sotirov, 2002).

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and comparison with coal from other Bulgarian basins (Sotirov et al., 2022).

THEORETICAL PART

Petrology (from Greek: *πέτρος* – "stone") is the branch of geology that studies rocks, respectively, coal as such, and the conditions under which they are formed.

Petrography is a branch of petrology dealing with the detailed description of rocks (coal).

Organic matter in coal, oil shale or sedimentary rocks originates from various plants and plant organs and, less commonly, from animals. It is heterogeneous (heterogeneous) and its components have been modified to varying degrees and in different ways both before and after deposition.

Macerals are microscopically identifiable individual constituents of organic matter. The words "maceration" and "to macerate" derive from the Latin verb "macerare", which means "to soak, soften, melt" (referring to the selective oxidative treatment of organic matter used in paleobotany). The term "maceral" was first used by Stopes (1935) for an ingredient of coal isolated by soaking and melting, (Stach et al., 1982).

It is customary for all macerals to have the suffix "-inite" and are classified in the following three maceral groups: Vitrinite; Liptinitis; Inertinitis:

Vitrinites are charred products of humic substances that originate from lignin and cellulose from plant cell walls.

Liptinites are derived from non-moisturizing materials, but from relatively hydrogen-rich plant debris such as sporopollenin, resins, waxes, and fats. Thus, the relatively higher aromatic fraction and the higher oxygen content are characteristic of vitrinites, while liptinites are distinguished by a higher aliphatic (paraffin) fraction and a correspondingly higher hydrogen content.

Inertinites are characterized by a relatively high carbon content, low hydrogen content and a very increased level of aromatization. Most inertinite macerals are derived from the same original plant substances as vitrinite and liptinite, but they have undergone a different primary transformation. For example, the cell walls of wood can be transformed into telinite (maceral of the vitrinite group) by treatment by humification and gelification, while change at an early stage, such as charring due to forest fires, can lead to the formation of fusinite or semifusinite (macerals of the inertinite group). (Stach et al., 1982).

A STORY ON A PROBLEM

Since coalification and the genesis of oil depend on the same digenetic factors (temperature and time), each stage of oil maturation can be compared to a specific rank of coal. The change of oil with an increase in diagenesis (from mainly aromatic to predominantly paraffinic) and its later destruction (volatility) can also be associated with certain stages of increasing coal grade.

The importance of coal petrology in the search for oil and natural gas lies in the fact that the degree of diagenesis (the whole set of changes in sediments, from their initial form to their transformation into metamorphic rocks) of both source and reservoir rocks can be determined relatively quickly and accurately by measurements of the reflectivity of vitrinite inclusions, according to. Teichmuller (1958, 1971), (Stach et al., 1982).

Since oil does not usually migrate long distances, the reflection values for both source and reservoir rocks usually do not differ significantly from each other. Nevertheless, it sometimes happens that crude oil migrates upward over considerable distances.

The occurrence of important economic natural gas deposits also depends on the degree of diagenesis and is therefore closely related to the coal class. Natural gas (methane and higher hydrocarbons) not only arises from bituminous substances, especially in oil rocks, but also from huminites in minerogenic rocks and coal seams. For example, in Slochteren (Netherlands) there is an important natural gas deposit, which originates from coal gases from hard coal in depth.

Jungen and Karweil (1966) show that in the various stages of carbonification from highly volatile bituminous coal (40% volatile matter) to anthracite (5%), large but varying amounts of methane are realized by coal. Most methane is formed during anthracitization. According to Van Heek et al. (1971), the formation of methane from coal begins at a temperature of 80°C in the sub-bituminous coal stage and first occurs significantly when the temperature exceeds 110°C in the bituminous coal stage, (Stach et al., 1982).

Bituminous macerals release methane (and higher gaseous hydrocarbons) earlier than huminite macerals. Only a small part of the coal gas is adsorbed from the coal, with the majority (in anthracites 90-95%) escaping into the upper rock, where it can, depending on the appropriate conditions of permeability on the one hand and impermeability on the other, concentrate in porous reservoir rocks, thus forming gas deposits. Important economic gas deposits usually occur first at a vitrinite reflection coefficient of 1.0% (in oil immersion) (Stach et al., 1982).

Coal gasification. This discussion does not deal with *in situ* or underground gasification of coal deposits, which cannot always be extracted economically and due to some environmental aspects. In underground gasification, the target coal is reached by one or more wells that are connected to a flow channel. They also ignite the air, oxygen and/or steam pumped into the well to react with the coal and produce carbon monoxide, hydrogen, methane and some other gases, all wishing to rise to the surface through the second or production well.

Industrial gasification of coal after its extraction involves the reaction of feed coal with an oxidizer (air or oxygen) and steam. Sulfur in coal is transformed into hydrogen sulfide, and nitrogen into ammonia. Although the volatiles in coal contribute to gasification, only the carbon of coal should be considered, according to White, (1979), (Taylor et al., 1998).

The mixture of CO and H2 is called syngas and can be used directly as a commercial fuel with an average thermal value, as an intermediate in the production of methane from coal, in the production or improvement of liquid fuels derived from coal, and in the chemical industry. Methane is also of interest in areas where natural gas supplies need to be supplemented to meet pipeline gas demand, write Durie and Smith (1975), (Taylor et al., 1998).

The methods of industrial gasification (not underground – *in situ*) are: gasification in a fluidized bed, gasification in a fixed layer, gasification with an engulfed flow, gasification in a molten bath, but this is also not a topic of discussion.

Petrographic characteristics of coal for gasification. One strategy in gasification is to use the highest possible temperature, as this results in more complete gasification of coal and less tar production. However, high-temperature gasification not only creates engineering problems, but also places high demands on the characteristics of coal.

Since gasification, as a coal conversion process, is less sensitive to the composition of coal than, for example, coalification, a wide range of coal can be used for gasification, although coal with high reactivity is preferable. For this reason, low-grade coal, maceral-rich coals from the liptinite group are extremely suitable, especially for fluidized bed gasification. The high moisture content of low-grade coal in this case may not be a disadvantage, since water is required for the reaction, and in practice it may not be necessary to add external water to the gasifier, however, moisture technologically represents a load burden. However, coal, which decays poorly when moisture is lost, is undesirable for use in reactors that cannot handle fine particles (White, 1979). (Taylor et al., 1998).

When using bituminous coal as a raw material, the high content of macerals of the inertinite group is an advantage because it inhibits excessive compaction and swelling, which are not desirable. Clumping results in a reduced gasification rate and can also cause mechanical blockage of the gasifier (White, 1979). If low inertinite bituminous coal is to be used, the bonding properties can be achieved by pre-oxidizing the coal. (Taylor et al., 1998).

The mineral content filling the coal should be as low as possible, as the ash occupies the reactor space, thus reducing the efficient use of the gasifier.

Many authors publish data on a relationship between the depth of the main coal seam and the formation of methane from coal. For example, Thomas, L.; Dawson F.M.; Faiz, M. et al. (Mastalerz et al., 1999). They found that the most promising for the search for methane are coal seams with a depth of between 300 and 800 m, with the highest methane content in the rocks about 500 m deep of the coal seams.

DISCUSSION

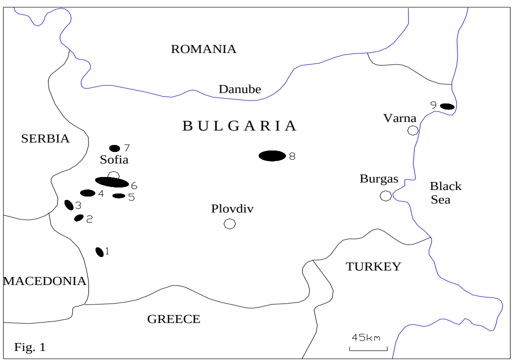


Fig. 1 Location of the studied coal basins: 1-Oranovo; 2-Katrishte; 3-Kyustendil; 4-Pernik; 5-Chukurovo; 6-Sofia; 7-Svoge; 8-Balkan; 9-Dobrudja. (Sotirov, 2013, 2007)

Literature data from Sotirov (2013, 2007) on the petrographic and mineral composition of coal from nine Bulgarian basins were used for petrographic evaluation of coal to form natural gas and for industrial gasification of coal. These are the Kyustendil, Oranovo-Simitli, Chukurovo, Sofia, Pernik basins, Dobrudja, Balkan, Svoge basins and the Katrishte deposit.

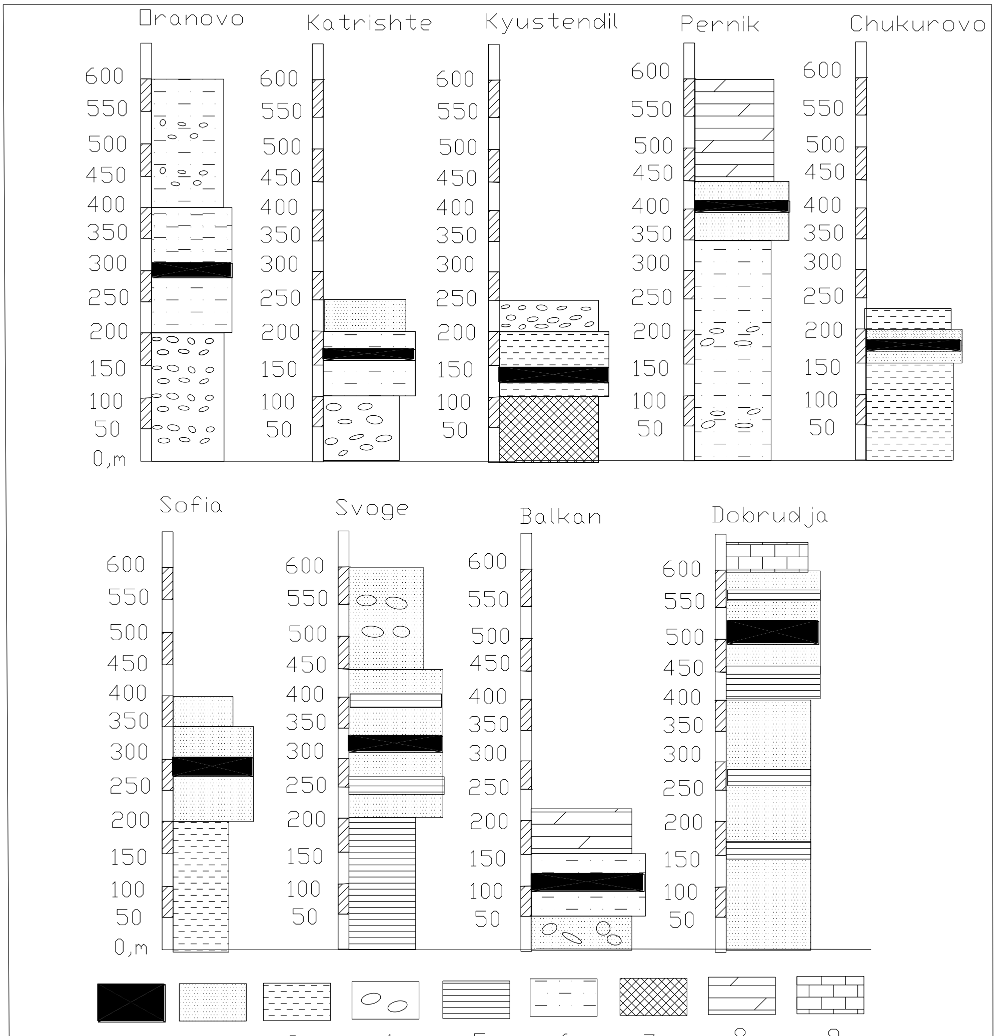


Fig. 2

Fig. 2 Summary lithological columns of the under layer, coal-bearing and covering layers of the studied basins: 1-coal; 2-sandstone; 3-clay; 4-conglomerate; 5-silt; 6-sandy clay; 7-crystalline rocks; 8-marlstone; 9-limestone.

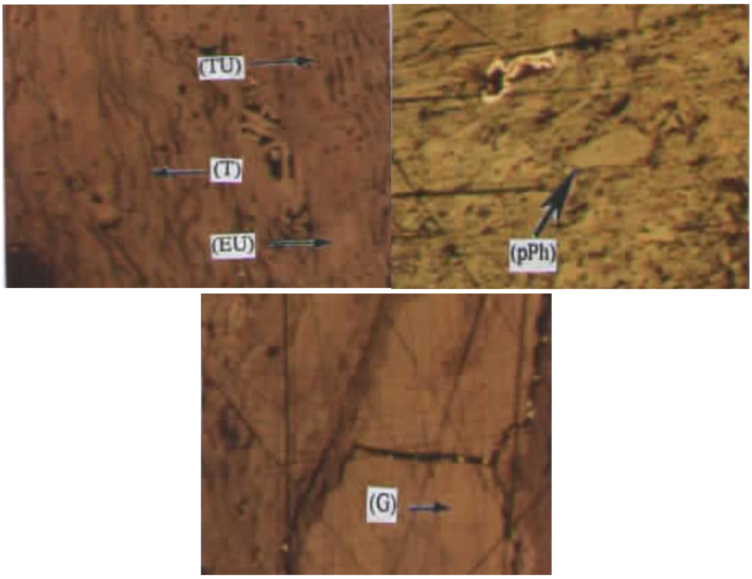
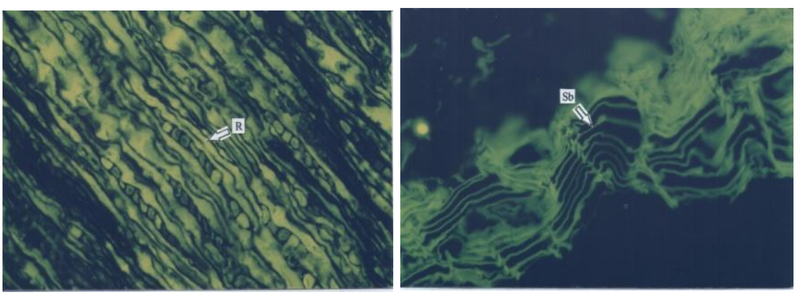


Fig. 3 Macerals of the Vitrinite group in the studied basins: TU-Texto-ulminite, T-Textinite; EU-Eu-ulminite, magnification x 400, reflected light, oil immersion. (Sotirov et al., 2019)



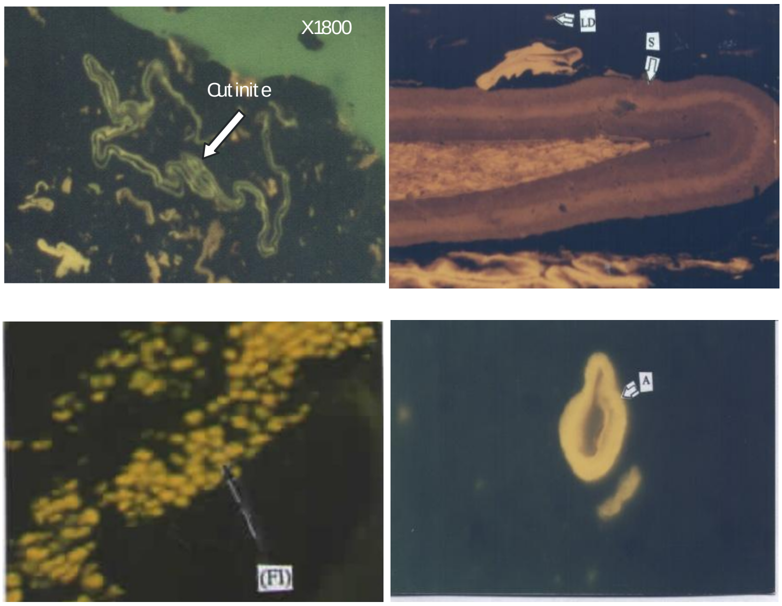


Fig. 4 Macerals from the Liptinite group in the studied basins: R-Resinite, Sb-Suberinite, Q-Cutinite, Fl-Fluorinite, A-Alginite, S-Sporinite, LD-Liptodetrinite, magnification x 400, fluorescent light, oil immersion. (Sotirov et al., 2019)

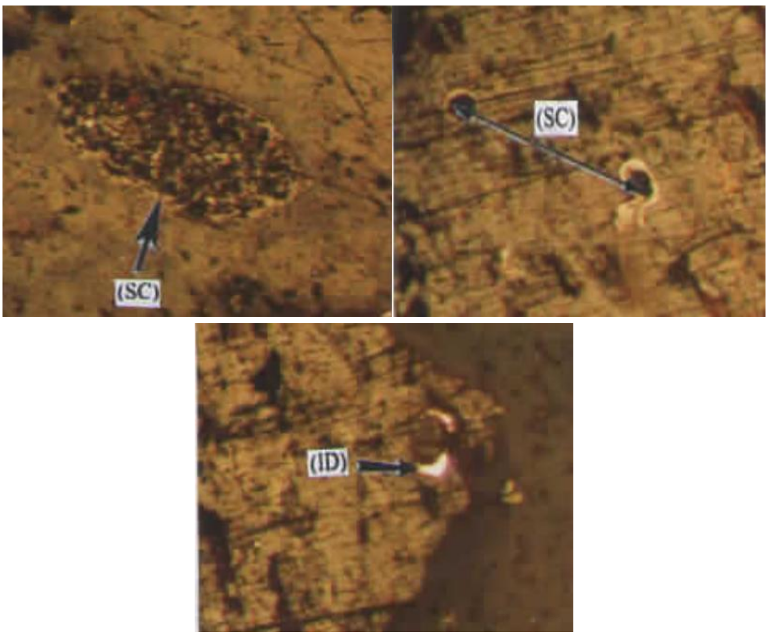


Fig. 5 Macerals of the Inertinite group in the studied basins: SC-Sclerocinite-multi-chamber, SC-Sclerocinite-single-chamber, ID-Inertodetrinite, magnification x 400, reflected light, oil immersion. (Sotirov et al., 2019)

Table 1 Petrographic data for the studied coal with a low degree of coalification (Sotirov, 2013)

On average, % of the total substance	Sofia Basin	Kyustendil Basin	Katrishte deposit	Oranovo Basin	Chukurovo Basin	Pernik Basin
Degree of coalification-Rank	Lignite	Lignite	Lignite	Lignite	Lignite	Sub-bituminous-B
Reflectivity of the vitrinite-Rr, %	0.23	0.28	0.31	0.33	0.37	0.48
Vitrinite, %	69.00	81.50	77.02	74.24	66.49	85.95
Liptinite, %	15.00	4.99	9.02	14.76	14.12	5.02
Inertinite, %	3.00	3.01	4.01	2.00	0.27	1.03
Minerals, %	13.00	8.00	10.00	9.00	3.06	8.00
Average depth of the main coal seam, m (Sotirov, 2013)	Up to 500	Up to 500	Up to 100	1200	700	Up to 130

Table 2 Petrographic data on the studied coal with a high degree of coalification (Sotirov, 2013)

On average, % of the total substance	Dobrudja Basin	Balkan Basin	Svoge Basin
Degree of coalification-Rank	High-volatile Bituminous-A	High-volatile bituminous-A	Anthracite/Meta-anthracite

Vitrinite Reflectance-Rr, %	0.79	1.12	4.89
Vutrinite, %	60.65	71.57	96.69
Liptinite, %	14.59	1.83	0.00
Inertinite, %	24.61	6.44	0.02
Minerals, %	0.15	20.16	3.29
Average depth of the main coal seam, m (Sotirov, 2013)	1500	140	300

CONCLUSIONS

Based on the information given above and the data on the petrographic composition of the coal from the studied nine Bulgarian basins, the following conclusions can be drawn:

1. Coal from the Balkan and Svoge coal basins are promising for exploration for conventional natural gas, as the measured values of reflections of the vitrinite are over 1.0%, respectively 1.12% for coal from the Balkan basin and 4.89% for coal from the Svoge anthracite basin. Naturally, there are many other factors, in addition to petrographic ones, that must be taken into account, such as tectonics, geology, etc.;
2. Promising for exploration for the extraction of coal for industrial gasification (not underground – *in situ*) are the lignite from the Sofia Coal Basin, containing macerals from the group of liptinite 15%, the Oranovo-Simitli coal basin 14.76% and the Chukurovo coal basin with 14.12% macerals from the group of liptinite. They respectively have a relatively low mineral content of less than 10%, with the exception of the Sofia basin, who has a little more.
3. Promising for exploration for the extraction of natural methane are Sofia, Kyustendil (depth of the main coal seam up to 500 m) and partly Chukurovo coal basins (700 m).

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9. PETROLEUM PRODUCTS IN KATRISHTE COAL DEPOSIT AND SEDIMENTS

(Sotirov, 2013).

Introduction. The term migrabitumen was introduced by Alpern (1978) and signifies bituminous material that has migrated [1]. It signifies secondary bitumen generated from fossil organic material during diagenesis and catagenesis. Migrabitumen may range from a fraction of a millimeter to several kilometers. In contrast to most macerals, the migrabitumens are amorphous, their shape adapts to the form of the cavities they occupy (interstices, fissures, cavities in microfossils, diffuse disseminations) (International Committee for Coal Petrology ICC, 1993).

Migrabitumen can be partly analyzed by the same methods as macerals, but unlike macerals these substances cannot be characterized unequivocally by their optical properties. Migrabitumen is therefore not a maceral term and cannot be included in Stopes-Heerlen system (International Committee for Coal Petrology ICC, 1993).

Application of the migrabitumen is mainly technical: for asphalt and as petroleum and natural gas indicator if suitable trap structures are presented, natural gas or condensate may occur. Where asphalt seeps, occur of petroleum most probably exists in the subsurface. Numerous occurrences of dispersed, non-metamorphic migrabitumen in a small area may indicate petroleum. Dispersed metamorphic migrabitumen, particularly impsonites, may imply that little petroleum can be expected; if suitable trap structures are present, natural gas or condensate might occur. Oil and petroleum coke can be obtained from ozokerite and asphaltites by pyrolysis. Impsonite was temporarily mined as coal. In addition vanadium can be obtained from some impsonite ashes (International Committee for Coal Petrology ICC, 1993).

Methods. A total number of 108 samples are studied as follows: Katrishte-43, Balkan-15, Dobrudja-20, Pernik-30. The coal pieces were crushed to a grain size 1-3 mm, covered by resin and polished for microscopic study under incident white (546 nm) and fluorescing (blue excitation) light. A microscope “Leica” with a computer program “Leica mpv_meas” and objectives 50x/0.85 and 100x/1.25 with oil immersion (glycerine) is used. An automatic counter “Prior-G” is used for counting of the macerals. Between 400 and 700 points (fluorescing and non-fluorescing) are counted on every sample for calculation of their percentage. The percentage of the macerals is calculated on the basis of the organic matter of the samples.

Results and discussion. Some Bulgarian coal was studied with fluorescence microscopy: coal from Balkan basin, Dobrudzha basin, Pernik basin, and Katrishte deposit.

Sotirov (2006,2007) established bituminite about 3% in Depost of Katrishte (lignite coal), but because the bituminite matrix is not a maceral it was not counted. Many samples exceeds 40% bituminite matrix in coal from Katrishte deposit. According to Powell et al. (1982) the presence of bituminite in excess of 10% of the organic matter is clearly indicative of a potential petroleum source rock (Taylor, et al., 1998). Bituminite is an indicator, but it has no significant practical importance. The migrabitumen in Katrishte coal is from subgroup asphaltite with brownish fluorescence (Fig.1).

Dobrudzha basin (high volatile bituminous-A coal) has bituminite below 1% and exsudatinite about 0,05%, but there is migrabitumen from 0% to more than 20% in separate samples. Migrabitumen might be seen between mineral matter of the carbonate and clay shales also. The migrabitumen is from subgroup asphaltite with brownish fluorescence (Fig.2).

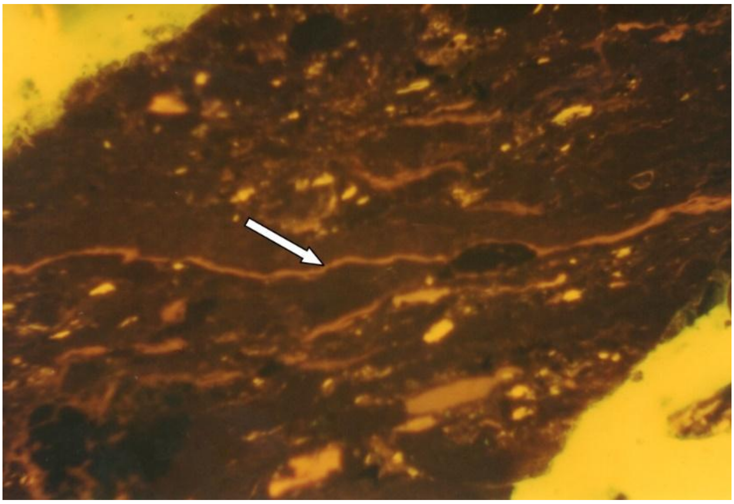

Fig. 1 Migrabitumen from subgroup asphaltite in the coal from Katrishte deposit, fluorescent light, oil immersion, magnification x1800

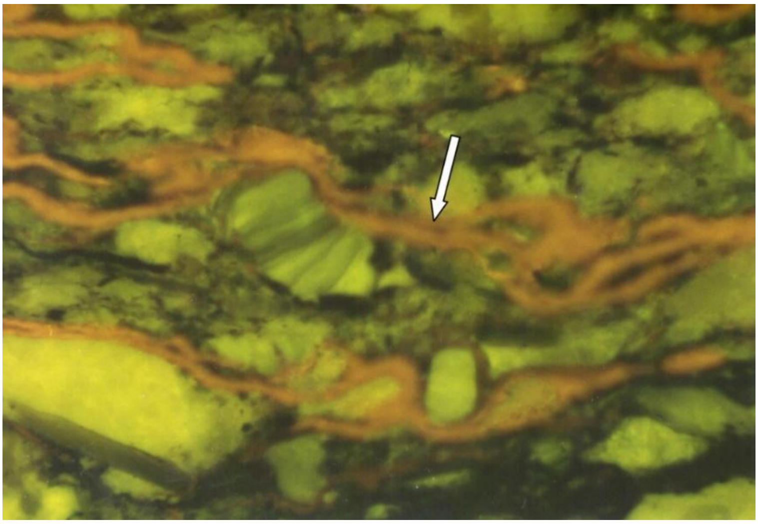

Fig. 2 Migrabitumen from subgroup asphaltite in the coal from Dobrudzha basin, fluorescent light, oil immersion, magnification x1800

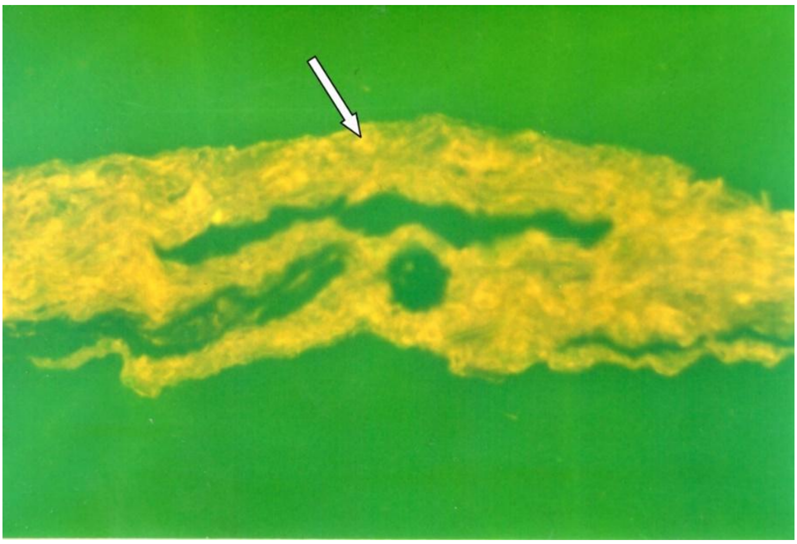

Fig. 3 Migrabitumen from subgroup asphaltite mixed with migrabitumen type ozocerite in the coal from Balkan basin, fluorescent light, oil immersion, magnification x1800

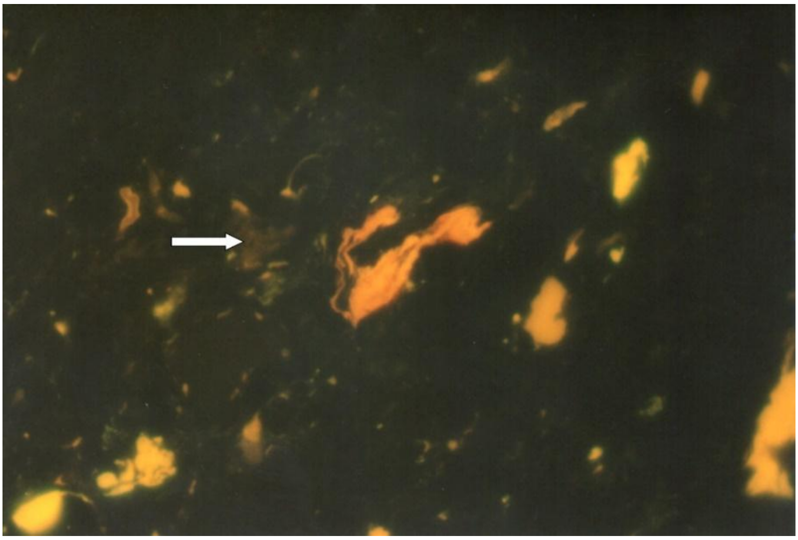

Fig. 4 Migrabitumen subgroup asphaltite in the coal from Pernik basin, fluorescent light, oil immersion, magnification x1800

Coal from Balkan basin (high volatile bituminous-A coal) has maceral bituminite about 1,83% (Sotirov, 2006,2007). Migrabitumen in this coal varies between 0% and 30%. Migrabitumen is some mixture of subgroup asphaltite with brownish fluorescence color and migrabitumen type ozocerite yellow fluorescence color (Fig.3).

Pernik basin (sub-bituminous-B coal) has maceral bituminite about 1%, and the observed migrabitumen varies between 0% and 1% in the samples. The migrabitumen is subgroup asphaltite with brownish fluorescence color (Fig.4).

Conclusion: The coals from Dobrudzha basin, Balkan basin and Katrishte deposit are potential source of bitumen products. The amount of the bituminite in single samples exceeds 10% and it is an indicator for potential petroleum source rock. Migrabitumen is mainly subgroup asphaltite, which is indicative for possible presence of asphalt or petroleum potential of the coal and coal-bearing formations.

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10. KYUSTENDIL COAL BASIN

(Sotirov, 2025)

Location of the basin

The Kyustendil coal basin is located in southwestern Bulgaria. It occupies the northern part of the Kyustendil field. Its area is about 50-60 km^2, between the geographical coordinates 42°16´-42°22´ north latitude and 22°40´-22°45´ east longitude. In its southernmost part is the city of Kyustendil. It is connected to the city of Sofia by a railway line coming from Gyueshevo. Kyustendil is connected by roads with the cities of Sofia, Dupnitsa, with the village of Gyueshevo, and to the north through the village of Sovolyano with Bosilegrad, Serbia.

The most important waterway that drains the basin area is the Bistritsa River, which originates from Mount Ruen in the Osogovo Mountains. It surrounds the Lisets Mountain from the west and north, crosses the basin in the middle and flows into the Struma River. The maximum is in April and May 2.20-12.3 m^3/sec, and the minimum is in August and September 0.08-0.89 m^3/sec. Another river is Banska (Banshtitsa), which drains the Osogovo and Lisets mountains and passes along the southern borders of the basin. Its waters are of the same order.

The most characteristic geomorphological forms are those created by erosion and accumulation: valleys, ravines, terraces. The most significant are the terraces and valleys of the Bistritsa and Banska rivers. The Bistritsa River has one floodplain and three non-floodplain terraces, and the Banska River has one floodplain and one non-floodplain terrace.

Coal-bearing association

With a gradual transition, the sediments from the main coal layer into coal-bearing sediments. The lowest part of the coal complex is alternated with grey-green sandy clays and is too unclean.

The coal seam is 3 to 12 m thick. In this regard, it is more stable in the area of the village of Nikolichevtsi, near the village of Skrinyano. In the direction of the village of Sovolyano the ash content of the coal decreases and is layered with clay-sand layers, and in the southwestern direction towards the village of Lozno it is not developed at all. There, directly on top of the sediments of the main coal layer lie those of the upper coal seam, and enrichment with organic substances is established on the contact between them (Fig. 1).

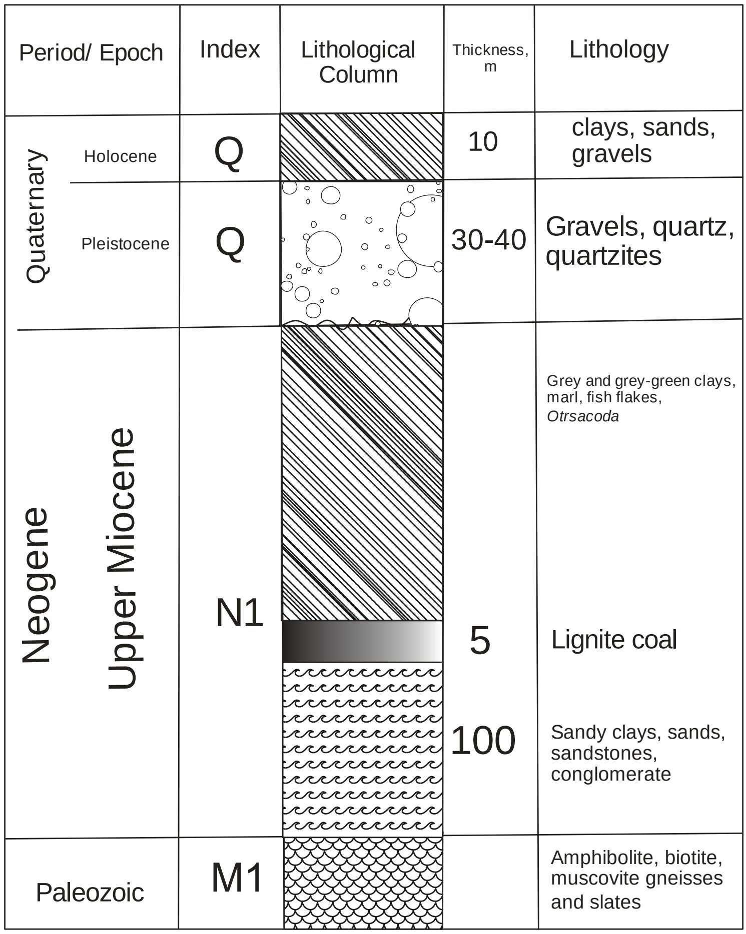

Fig. 1 Middle stratigraphic column, by Bl. Kamenov (1956).

Due to the strata nature and the calm tectonic position, discoveries of the coal seam are almost not observed. As such, very small spots can be pointed out at the village of Nikolichevtsi and the village of Sovolyano. The stratigraphic location of the coal coal-mining community, even where there were no coal-forming processes, is very characteristic. This boundary divides the Miocene sediments into two sharply distinguishing sterile sediments, basic and over-coal layer.

Upper coal association

This association is the thickest and the most durable with the most uniform lithological composition. This is typical for the basins of the Struma coal province, to which the Kyustendil basin belongs (Shishkov, 1985). The fellowship is built mainly of grey to grey-green clays, in some places turning into schistose clays, marls with calcium carbonate from 8.5 to 21.4% (Fig. 2), grey to ashy light schistose clays with layers of aquifer clay sand. Grey-green clays predominate. With a thickness of 2-3 m are ashy schist clays with calcareous substance. The thickness of the marls is 15-20 cm. From a few meters to 25 m is the thickness of the aquifer sandy clays.

Fig. 2. 1-Over-coal clays; 2-coal clays; 3-coal; 4-under-coal clays.

Immediately above the coal layer, there is a zone with a thickness of 2-3 m with brown relatively light schistose clays, in some places with the remains of shells of the *Planorbis* snails. Among the clay materials there are plant relics, scales and teeth of fish and shells of *Planorbis*, which, however, do not characterize a certain level. Some clays are rich in the remains of one-cell algae *Diatomea* and turn into diatomaceous clays, while others contain the arthropod *Ostracoda*. Alexiev, El. (1958), found that these clays are illite. They contain in small quantities montmorillonite, halloysite, organic matter, quartz and insignificant amounts of pyrite and marcasite. According to the content of organic and carbonate matter, it divides these groups into 5 types; illites, rich in calcite, containing dolomite, containing siderite and rich in organic matter. The total thickness of the coal mine is 500 m. It is revealed on the surface in limited areas, above the villages of Skrinyano and the village of Nikolichevtsi.

Hypotheses about the age of the coal deposits

Into one of the first samples near the village of Sovolyano in 1951, in the clay-sandy layers of the coal seam, several pieces of teeth of a large mammal, probably *Deinotherium giganteum* – a precursor of elephants and mammoths, were found. Information about such a find at the same place was published by Bakalov (Nikolov, 1974). Based on them, Bakalov attributes the coal-bearing sediments near the village of Sovolyano to the Upper Miocene. According to him, the remains of *Deinotherium* belong to the *minor race*, which is older and appeared in the Miocene, while the large *race major* lived in the Pliocene. Taking into account the degree of coalification, which is more advanced compared to the coal from the Sofia Basin (late Miocene-early Pliocene) under the same conditions - starting material, containing rocks, depth of occurrence and tectonics, the Upper Miocene age is assumed, which epoch is known as coal-forming.

Geology of the coal seam. Construction of the layer

The coal layer were tracked with drilling in almost all directions. The development is also unclear only in the northwest and southeast directions, i.e. in the two opposite sections along the syncline. In the south-eastern direction, due to the great depth (over 50 m), in the northwest direction – due to the deterioration of the reservoir quality, it is not advisable to set more drillings.

There is only one coal seam. It is developed mainly in the north-eastern wing of the syncline. In the southwestern wing, with the exception of the section near the village of Sovolyano, there were no coal formation processes at all.

In the south-eastern part of the basin, the coal seam emerges as the most compact and clean. Very rarely there are layers of very small thickness of black clays among it. The content of black clays increases in the northwest direction, with the bundles becoming thicker. Northwest of the village of Skrynano, the thickness of the sterile layers increases and reaches about 1 m.

The total thickness is the entire thickness of the coal seam from top to bottom, including the sterile layers. The thickness applies only to pure coal. For coal, bundles with dry ash of no more than 45% and rarely thin layers of coal clays with ash of 50-74% are accepted.

The coal seam in a section of the village of Nikolichevtsi is the cleanest and most compact. The thickness of the layer in this section varies from 3 to 5 m. The useful thickness is 4.65 meters on average, the depth of the layer is 200-270 m, dry ash is 29.8%.

In the southern direction towards the city of Kyustendil, the coal seam gradually sinks to a fairly great depth.

In the Skrinski section and to the west of it, layers of black clays, clays and sandy clays are observed among the coal. Here the layer is located at a shallower depth - an average of 200 m.

The sterile layers in the coal seam are black clays with coal (organic) substance, rarely sandy clays, which pass into weakly coalesced clays and sandstones. Their thickness is between 0.05-1 m. In many places, immediately above the coal layer, there is a layer 1 m thick, overflowing in places with small *Planorbis* fossils, which is marking.

The upper limit is clays and marls, and the lower limit is sandy clays and poorly welded clay sandstones.

Genesis of the deposit /by Bl. Kamenov, 1956/

The sediments of the main unproductive coal layer of the Miocene are brecciated weakly coalesced conglomerates, which gradually shrink upwards to pass into fine and fine-sandy clays, speak of a normal transgressive sedimentation. Once the water basin was created, under favourable climatic conditions (warm and humid climate), peat bogs with lush marsh vegetation, higher juniper vegetation were formed, proof of which are the fossil trees found among the coal. *Planorbis,* which are found in abundance, are an indication of the swampy nature of the basin.

The conditions for peat formation were quite diverse both horizontally and vertically. More favourable conditions for peat formation were in the eastern part of the basin, while in the western part there were none. As an explanation, it can be assumed that in the eastern part of the basin it was relatively shallow, and in the western part it was deep and abundant terrigenous material came.

The stratification and claying of the coal seam, which is observed to the west and northwest of the village of Skrinyano, can be explained by oscillatory movements during peat genesis. There were times when the bottom quickly lowered, during which the peat bog sank and clay sediments, in some cases sandy, were layered on it. It can also occur when the swamp is flooded or dried, and consequently increases the depth of the water or decreases and moves the water level up or down, either due to an increase or decrease in water inflow, but it can also be due to an increase or decrease in the contribution of sediments. After the swamp was braided again, the peat bog was revived. After this favourable period for peat formation, the basin slowly but steadily deepens. Plant materials are covered by thick clay sediments reaching over 500 m.

After the disappearance of the Pliocene lake and the subsequent bending of the deposited materials, a river was formed, which collected the violently flowing streams from the Lisets and Osogovo mountains. This river crosses the basin in a north-south direction, forming a deep erosion valley. After the formation of this valley, a period of lowering of the basin occurred, during which it was filled with terrigenous materials. In this situation, the waters of today's Dragovishtitsa River settled to the east of the Struma River and began to form a separate valley of their own. At that time, today's Bistritsa River was formed, which crosses the old valley across, gradually forming its present wide and terraced valley. From the village of Sovolyano to the village of Skrinyano, the Bistritsa River forms its valley in gravel deposits of the buried valley, and from the village of Skrinyano to the village of Shishkovtsi it passes the existing Miocene massif, beginning to accumulate material only at the formation of the floodplain and the first non-floodplain terrace.

Methodology of the conducted research

For the purposes of the current research, 20 coal samples and 4 of the host rocks have been collected. The coal samples were collected according to a point sampling scheme every 20 cm from the face of the 29 material gallery. The rocks from the top, the bottom of the layer and the layers of clay in the coal have been tested.

Microscopic preparations were prepared from the coal samples in the grinding laboratory of the University of Mining and Geology "St. Ivan Rilski", MSU-Sofia according to the accepted methodology BDS 14952-79.

The coal pieces for the preparation of the anschliffs (polished cross-sections) are briquette and are soldered in standard shapes with polyester resin. Polishing of microscopic preparations was carried out by sequential treatment with diamond pastes with abrasive particle sizes 7-5; 3-5; 2-3; 1-0.1 μm on metal discs, glass and textile canvas.

The optical examinations were carried out with a *Carl Zeiss Jena microscope* in an air environment. The magnifications used are 64, x160 and x400 times.

For the detection of minerals finely mixed with each other with organic matter, X-ray diffractometry was used, performed using an X-ray diffractometer of type *DRON-1* (Russia), with a copper anticathode and a cobalt filter at a current of 20 mA and a voltage of 34 kV.

To collect additional information necessary for the reliable diagnosis of minerals in their mixtures with organic matter – mainly clay and carbonate minerals, differential-thermal analysis DTA was used. This analysis was carried out on equipment type *Derivatograph-3427* (Hungary) on 2 coal samples at the Central Research Laboratory of Geochemistry at University of Mining and Geology “St. Ivan Rilski” (MGU) Sofia under the following conditions: initial temperature 15°C, maximum temperature 1000°C, average heating rate 2°C/min in ceramic crucibles in air with inert substance Al_2O_3.

X-ray structural analysis of pyrite from coal using the Debye-Scherrer method was performed at the National Geochemistry Centre at University of Mining and Geology “St. Ivan Rilski” (MGU) Sofia. Cobalt anticathodes with unfiltered radiation at a voltage of 30 kV and a current of 12 mA were used.

In the chemical laboratory of the National Geochemistry Centre at MGU-Sofia, analyses of the ash content of 15 samples of pure coal and 5 samples of clay coal were made.

Micro-petrographic composition of coal

Maceral composition. Macerals – (*macerare* (*gr.)* - to melt, soften, dissolve) are coalized and altered plant residues and their decomposition products as a result of various physicochemical and biogeochemical processes. They are important for determining the paleoenvironment of the peat bog and for the economic evaluation of coal – propensity to spontaneous combustion, oxidation ability – used in coking coal, the ability of coal to be a source of hydrocarbons and hydrogen, i.e. for gasification and many others.

In the studied coals, macerals from the three groups of the Stops-Heerlen classification are observed (Pesheva, 1979).

Huminite Group, Subgroup Humotelinite

Textinite: It is found in all the preparations studied. The plant structure is clearly visible. These are small cell openings with strongly thickened walls. The openings are oval, rarely oblong. In some preparations there are pronounced annual circles. More often it is in the form of stripes and less often lenses. The cell openings are usually empty, but sometimes they are filled with clay matter.

Ulminite: Also found in all preparations. It is a plant tissue with impaired cell structure. It is mainly represented by the maceral types texto-ulminite and eu-ulminite. Texto-ulminite has empty holes or they are filled with a mineral substance.

Subgroup Humodetrinite

Humodethrinite: In the examined cross-sections, it is the main part of the carbonaceous substance. It acts as a binding mass. It is a mixture of plant detritus and mineral substance, mainly clay minerals with quartz. It is represented by the maceral types of attrinite and densinite, with the first type predominating. Attrinite is not well compacted and with coarser particles. Densinite is very well compacted.

Subgroup Humocolinite

Gelinite: Observed in the form of stripes and lenses. Structureless, with characteristic perpendicular cracks to each other, rare.

Corpohuminite: It occurs more often, in most cases it fills the cells of the textinite, in other cases it is like a cluster of rounded or irregular bodies of organic matter.

Liptinite Group

Resinitie: Individual small bodies, most often oval in shape. Its relief is higher than that of the main mass, but it is closer to the relief of gelified macerals, i.e. not very tall. It usually fills individual larger cell openings.

Sporinite: It is represented by macro- and micro-sporinite. Macro-spores are conventionally named because of their larger size of the same species, possibly due to their more complete section in the sample. These are spore shells and pollen without a three-pointed suture. Macro-spores are single findings, several in number and their interior is filled with clay substance. They are usually elongated. Microspores are more often round and filled with organic matter.

Suberinite: Rarely found in preparations. It is the remains of cork tissue of higher plants. It has a pronounced cell structure, in the form of stripes around the gelified macerals. The openings of the cells are oblong and small in size.

Cutinite: Only one cuticle was found in the studied preparations, which is controversial and it cannot be determined whether it is in a disturbed form or not. The reason for the uncertain diagnosis of the Macerals of the Liptinite group is the lack of a fluorescence microscope during the examinations.

Alginite: Often found in almost all samples. They are observed as irregular bodies but close to oval. They have a high relief, a reticulated interior, and often form colonies of the unicellular *Algae*.

Liptodetrinite: These are clusters or scatterings of lipid macerals that, due to their small size and irregular shape, cannot be determined with certainty.

Inertinite Group

Fusinite: It is very rare in preparations, usually in those in which clay is predominant. It is observed with a high relief, well-preserved cell structure, with round and oblong openings, most often filled with clay substance. It has a silky sheen, similar to charcoal.

Sclerocinite: Occurs in small quantities, singly or at most in 2-3 specimens, located next to each other. It is a fungal spore. Filled with clay substance. Oval in shape with weak relief on the walls. They are usually single-chambered.

Inertodetrinite: It was rare found. These are small pieces with high relief and no structure. They are fragments of the remaining macerals of the inertinite group.

Mineral composition

Clay minerals, pyrite, marcasite and quartz are found in the observed cross-sections.

Clay minerals: They are most common and in a large percentage. They have a low relief, dark brown color. They fill the holes of gelified macerals, cracks or are finely mixed with humo-detrinite. They are of terra-genetic origin.

Pyrite and marcasite: They cannot be separated under a microscope, but other studies show the simultaneous presence of both minerals. They occur separately. Most often they occur as single grains of irregular shape, scattered unevenly in the annals. There is also massive pyrite – grains with irregular shapes. Framboidal – rounded microbial formations. Grape-like (clustered) pyrite from clusters of mineral grains. Euhydral – well-formed crystals. Both syn-genetic and epigenetic forms of these two minerals are established. Under a microscope, bright yellow with a high relief and a dark halo around the mineral grains.

Quartz: It is very rare, only in a few preparations in the form of small oval grains with high relief. It is dark grey in colour, with a dark halo around the grains.

Distribution of macerals and minerals along the seam profile

In the coal seam, a certain regularity is found in the distribution of macerals and minerals.

At the base of the layer, exclusively macerals of the Huminite group, together with the Liptinite group, are observed.

Towards the middle of the layer, layers of the microlithotype of carbargillite appear, which is often associated with fusenized macerals. In the middle of the layer, the amount of the Liptinite group decreases, the inertinite group increases.

In the upper part of the layer, the Liptinite group almost disappears and mostly the macerals of the Huminite group predominate.

All this indicates that the redox potential Eh of the environment was about +400 mV at an acidity pH of 3-9.

The presence of preserved remains of fusenized macerals in association with clay indicates their introduction during tectonic movements.

Pyrite and quartz are unevenly distributed, but there is a slight affiliation to clay minerals (Fig. 3).

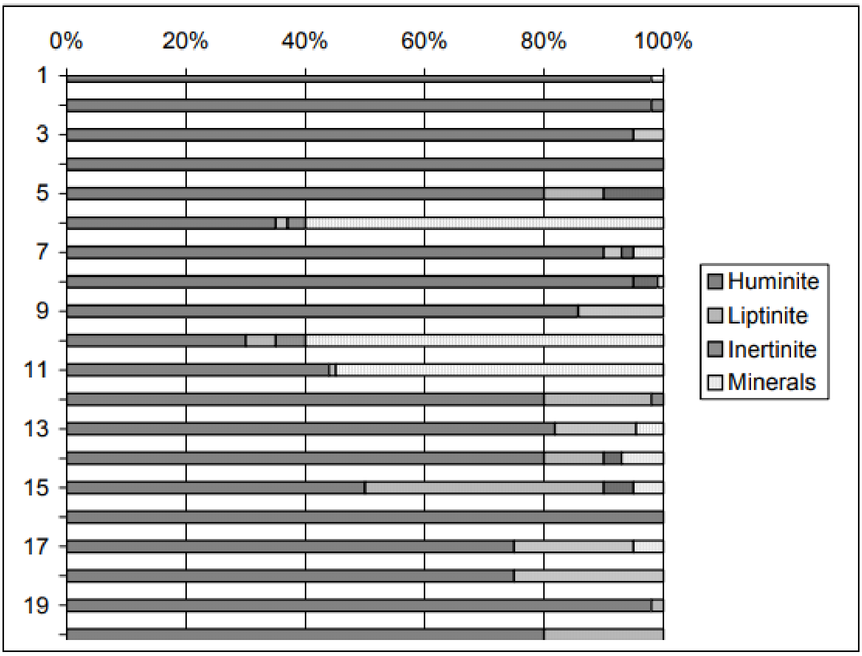

Fig. 3. Distribution of maceral groups and mineral content in the seam profile. Along the X axis – percentage of maceral groups and mineral content. On the Y axis – number of samples (20) taken at 20 cm in the seam profile.

Determination of the ability to spontaneous ignition of coal from the Skrinyano section

Petrographic studies of coal can be used to predict their propensity to spontaneously ignite. The most important petrographic prerequisites, according to Stach et al. (1978) are as follows:

1/ These macerals are the most porous and most easily oxidized and increase the temperature in the coal seam, thus causing the coal to spontaneously ignite. In addition, it should be noted here that fusinite is the product of forest fires or indicates very dry and hot periods, during which it accumulates a lot of internal heat or its combustion is quickly stopped by the incorporation of terrigenous material, similar to artificial charcoal.

2/ Presence of **fine-grained pyrite** in a content of 9 to 16%. When pyrite is oxidized, heat is released, which can provoke spontaneous combustion of the coal seam.

3/ The presence in the coal layer of layers with a large amount of **clay minerals,** which act as a thermal insulator and cause heat to accumulate in the coal layers between them.

From what has been said above about the distribution of coal along the section of the seam, the following is established:

1/ Fusinated macerals are completely absent from the lower part of the layer. In the middle part of the layer they are in a small amount and are in the high ash layers, which do not spontaneously ignite. And in the upper part of the layer, only one sample No. 5 was found to have a larger amount of fusinite.

2/ As noted, the amount of pyrite does not exceed 5-7%, which is below the lower limit established by the research of Stach et al. (1978). A larger amount of pyrite and marcasite is found in only layer No. 14 in the middle of the layer.

3/ Layers with an increased content of clay minerals have been found in the coal seam, between which the coal layers are locked. These are between samples No. 2 and No. 6, between No. 6 and No. 10 and between samples No. 11 and No. 15.

From all that has been said so far, it follows that the spontaneous combustion of coal in the section is unlikely.

Conclusions:

1/ In the coal from the Skrinyano section of the Kyustendil coal basin, gelified macerals predominate with a very small amount of lipoid and especially fusinated macerals. This is a sign of low values of the redox potential Eh of the paleo-medium from 0 to +400 mV, i.e. the absence of oxidation conditions in the swamp. The observed micro components are the remains of higher plants decomposed in an aquatic environment.

2/ The presence of layers with an increased content of clay minerals is a sign of short-term sharp decreases in the earth's crust or possibly heavy rainfall, which bring terrigenous material into the peat bog through temporary water flows.

3/ A certain regularity is established in the distribution of macerals in the coal seam, with lipoid macerals being in the largest quantity in the lower part of the layer, and fusenized in the middle and especially in the upper part. The amount of gelificated macerals is large along the entire section of the layer.

4/ The autochthonous nature of coal is confirmed by the presence of intact macerals and wood remains, finely mixed with clay substance. Only individual stages of peat bog development, along with terrigenous material, single plant remains were introduced.

5/ Petrographic studies show that the coal in the section is not prone to spontaneous combustion.

Project for operational exploitation of the "Skrinyano" section of DM Bistritsa-Kyustendil

Degree of exploration of the deposit

A preliminary and detailed study was carried out.

The preliminary study was carried out with drilling boreholes of 1000x500 in order to determine the prospects of the basin. Preliminary data on the petrographic type and quality of coal are given. Reserves of 26 million tons have been calculated. tons of category B and C.

A detailed study was carried out in order to give a complete picture of the size of the coal seam, the tectonics of the region, the mining-technical and hydrogeological conditions for exploitation. Industrial category B stocks have been calculated.

The exploration was carried out exclusively with drilling and several mining workings for operational purposes.

The boreholes have been laid in 9 profile lines, which have the direction SE-SW, as a result of which the thickness of the cover in different parts of the pool is fully clarified. The coal seam could not be traced only in the NW and SE directions, due to deepening and deterioration of the stratum (Kamenov, Bl., 1954).

The exploration lines are located at a distance of 500 m from each other, and between the boreholes 500 and 250 m.

Spatial position of the layer and degree of variability in different directions

The Kyustendil coal basin has a relatively simple geological structure. The coal seam has pronounced elements of subsidence and extension and slightly variable thickness, but within the limits of the accepted conditions.

Tectonically, it is considered to be a syncline, with an NW-SE axis. During the formation of the coal seam and after it, there were oscillatory movements. In the SE-NW direction, the layer deteriorates its qualities, deepening in the SE layer, and completely disappearing in the SE layer.

Choice of exploration methodology

1. Morphology and manner of occurrence of coal seams. The slope of the layers is weak 5-10% to the south. In some places there are significant fluctuations in the elevations of the top and bottom.

2. Local fault structures and landslide phenomena. The landslide is in the area of the village of Skrinyano.

3. Ash content. It ranges from 32 to 40%, with the average being 36%.

4. Thickness of the coal seam. There is one coal seam with a thickness of 1 to 6.6 m. In this case it is 5.37 m.

5. Mining and technical conditions. Above the coal seam lies a clay-marl bed, which is very thick - over 500 m.

The design section is near the village of Skrinyano, where, due to engineering and technical reasons, it does not go deep into the village. In the development of the project for the operational study of the section, part of the old mine workings laid for the Skrinyano section, which are currently operating, will be used. The designed mine workings will be in an operational section, which makes the exploration more expensive, but subsequently they will be used in operation and will return their value.

Sampling

The sample must be representative, i.e. in its composition correspond to the average composition of the mineral in the sampled area.

The sample can be taken both from natural discoveries, fabrications, faces, drilling, and after blasting, when the mineral is in a disturbed form.

Spot and furrow sampling is used. The point line is on a grid with a certain density. The furrow is through furrows. They should be perpendicular to the coal seam.

Depending on the purpose, the following are used:

- Technical testing for determining the physical and mechanical characteristics of the coal and the rocks containing it. Moisture, ash content, volatile substances, coke residue and calorific value are determined.

- Chemical sampling to determine the content of major and minor useful components.

- Petroleum sampling to determine lithotypes, micro lithotype and maceral composition and mineral inclusions and impurities.

For the purpose of the project, the technical furrow sampling was adopted every 10 m along the length of the design workmanship. A total of 65 samples were collected.

Geological documentation

Primary geological documentation. It consists in daily systematic sketching and description of the products.

Summary geological documentation – includes the compilation, on the basis of the primary documentation, of generalized graphic materials for the entire deposit (plans, industrial profiles, drilling profiles, etc.).

The primary one includes: drilling columns on a scale of M 1:100 with a description of the core material, a sampling log, a sample processing log.

The summary includes: a geological map in M1:25000 with profiles, horizontal geological plans in M 1:2000 with profiles in M 1:1000, a geological report for the calculation of reserves.

Aims and objectives of the exploitation study

From the stage of the preliminary study, the general geological and structural features of the deposit and regularities in the distribution of the coal seam have been clarified. The main quality indicators of coal have also been determined. The exploitation survey begins with the handover of the deposit for exploitation and is carried out by the mine geological services.

The tasks of the operational study are:

- to prepare the field for exploitation by limiting the individual blocks.

- to bring mineral reserves from lower to higher categories.

- to indicate the preparatory and exploitation works and to monitor the proper recovery of the mineral.

- to clarify the cause of the losses and to identify measures to reduce them.

- to study in detail the genetic features and structure of the pool.

During operation, it is necessary to organize a systematic and targeted collection and aggregation of geological data.

Calculation of the coal resources

Selection and justification of the method for calculating of the resources

The reserves are calculated using the method of the operating blocks, taking into account the calm tectonics, relatively constant power and constant ash content of coal. The reserves in the section are now assigned to category B by a drilling network of 250x250 m.

The areas of the contoured blocks are determined by the method of dividing into simple figures.

The calculation of the stocks was carried out on the basis of the accepted conditions:

- minimum thickness of the layer 1 m.

- maximum ash content A^C<50%

-maximum depth 400 m

The contouring was made of one block in category A. The block was drawn by extending the 29th material gallery, from which the sampling was carried out, and the contour was extended to where the mining and technical conditions allowed, i.e. to the entrance to the village of Skrinyano. Here, to the south, the contour of the rifled workmanship is laid, which connects the 29th material gallery with the 29th export gallery, which will be the project and its contour is parallel to the first one. The cross-section of the workmanship is trapezoidal - with rounded upper corners. The size of the section is 5.30 m.

The shape of the block is rectangular. The length of the extension of the 29th material gallery is 200 m. The threaded workmanship is 36 m long. The length of the 29th removal gallery is 410 m. The total length of the designed works is 646 m.

Data from already designed wells were used. These are boreholes with numbers: 844, 848, 849, 850, 858, 864, 880, 881, 882, 883, 884, 885, 886, 887, 822, 875, and 847.

Two cuts were made according to the drilling data: for the 1st section: 864, 880, 882, 881, for the 2nd section: 850, 884, 886 in M 1:1000 horizontal scale in linear vertical scale 1:5000 /Appendix 2/.

7.1 Essence of the method:

7.1.1 The average thickness of the block is calculated using the arithmetic mean method:

$m=m_1+ m_2+\ldots+ m_n / n$, where

m – average layer thickness, [m]

m_1, m_2, m_n – Layer thickness in individual boreholes, [m]

n – Number of boreholes used for output data.

7.1.2 Determination of the average ash content:

$A^d=A_1^d+A_2^d+\ldots+A_n^d / n$, [%], where

A^d-average ash content, [%]

A_1^d, A_2^d, A_n^d – average ash content in individual boreholes, [%]

n – Number of boreholes.

7.1.3 The volume of blocks is calculated using the formula:

V=S.m, [m^3], where

S – area of the block [m^2]

m – average thickness of the coal seam, [m]

V – block volume, [m^3]

7.1.4 Stocks are calculated according to the formula:

Q=V.d, [t], where

d – volumetric weight (average), [t/m^3]

($d=1.067+0.005xA^d$, [t/m^3])

V – block volume, [m^3]

Q – stocks, [t]

The initial data for the calculation of the reserves were taken from the actual boreholes drilled in the studied section. /Appendix 2/. The results data for the calculated stocks are given in Table 4.

Table 4 Results of the Operational Study Project.

№ of the block	Block Area S, (m^2)	Average layer thickness, m (m)	Block volume V, (m^3)	Average ash content of coal A^d, (%)	Average volumetric weight of coal d, (t/m^3)	Stocks in the Category A block Q, (t)
1	14760	5,37	79261,2	36	1,247	98838,7164

Economic assessment of the Kyustendil coal basin and the effectiveness of the proposed project for exploitation study

The city of Kyustendil is connected to the capital Sofia by a railway line (101 km) coming from the village of Gyueshevo and a road - European road E-871 (78 km), passing through Pernik, Radomir and continuing to Skopje-North Macedonia. Through roads and highway it is also connected to Dupnitsa, and from there to Blagoevgrad. Through the village of Sovolyano, the town of Kyustendil is connected to Bosilegrad-Serbia.

The nearest railway station is Kopilovtsi. The Nikolichevtsi Section of the Bistritsa coal mine is 2.5 km away.

The largest administrative centre is the city of Kyustendil. DM "Bistritsa" Ltd. is about 1.5 km from it. The nearest villages are Sovolyano, Skrinyanno, Nikolichevtsi, Perivol, Shishkovtsi, located on the outskirts of the basin.

The infrastructure of the region greatly facilitates the activities of the mining enterprise, due to the proximity to the settlements and convenient railway transport.

DM "Bistritsa" was an independent limited liability company, with the subject of activity production of coal and trade with it. The following structural units /sections/ are separated:

Two are digging, with the main task of coal mining. A preparatory section that aims to prepare galleries for operation. One capital section – for the transportation of the mined coal. One transport for the transport of people, materials and coal. All of them are interconnected with each other with a main goal - coal production.

The contractor companies with which the mine is in contact are: Plant for Reinforced Concrete Structures – ZSK-Kopilovtsi. From it he buys segments and reinforced concrete frames with dimensions of 2.20, 2.60 and 3.00 meters. From all the forestry plants in the district, the mine buys timber fasteners.

The electricity supply is provided by the company "Energy supply" - Kyustendil. Water needs are met by their own water sources. DM "Bistritsa" - Kyustendil does not have joint production with other companies.

The buyer companies are TPP-Bobov Dol, located nearby, and the battery plant in the town of Pazardzhik, which buy coal of class 0-20 mm for energy fuel. Coal of a class of more than 20 mm is sold to the public and private heating companies.

The sale can be directly to the buyer or through an intermediary company "Toplivo" - the town of Radomir. Coal is also sold in Sofia Circle, Vratsa and some other cities in the country.

Changes in the future can be expected primarily in the sale of products, as the number of intermediary companies increases. A competitor company is the coal mine in the town of Bobov Dol. The main goal of the enterprise was to expand production capacities, increase production fronts and preparatory work. It is planned to increase the yield from 100 thousand tons per year to 200 thousand tons per year until year 2000. It is necessary to work in the field of marketing in order to increase the number of buyers of coal for the industry, reducing the sales of coal for home heating, and at the same time to work for the introduction of environmentally friendly technologies in the use of coal and their usefulness in the chemical industry, and not only in the energy sector. These are state and private companies, private individuals and others. Sales in Serbia and Macedonia can be considered. Bosilegrad-Serbia is located only 45 km from Kyustendil, and Kriva Palanka-North Macedonia is 39 km away.

The traditional direction of using the raw coal product is as a fuel in industry and households. There are no new directions for now. It is possible in the future to use coal in the chemical industry.

The final product of the production activity is coal. Prices are determined according to demand. But the conjuncture of the product is low. The documented prices in Bulgaria as of April 1, 1993 are: for class 0-20 mm it is 180-200 lv (BGN)/t, and for class over 20 mm it is 200-260 lv/t (exchange rate against the German mark on that date 16.21 lv-BGN per 1 DEM) or:

The average selling price is 240,77 lv/t

The cost of coal is 883,41 lv/t

Based on the above data, the following can be calculated:

1/ Losses, lv/t=Cost (lv/t) – average selling price (lv/t)=642,64 lv/t

2/ Balance Stocks = 32 mln.t

3/ Power and area losses are 25% on average.

4/ Extractable stock reserves (t) = Balance stock reserves x 25%, i.e. 24 mln.t

5/ Total value of the deposit = balance reserves (t) x Price of 1 tonne of coal (lv), i.e. 7704640000 lv.

6/ Extractable value of the deposit = Extractable reserves (t) x price of 1 ton of coal (lv), i.e. 5778480000 lv. (Table 5,6).

By 1960, the deposit was explored by external organizations, which confirmed the reserves. The Bistritsa mine has been exploring with its own funds for the rest of the years. Detailed studies have been carried out. After 1991, research stopped due to lack of funds.

Geophysical and drilling works are not carried out. The cost of owning your own chemical laboratory is minimal. The cost for one sample of technical furrow sampling is BGN 300.

For the purpose of this project, a technical furrow sampling has been adopted every 10 m along the length of the design workmanship, with costs for each sampling of BGN 300. A total of 65 samples are planned for the entire length of the design works.

The length of the designed operational exploration workings is 646 m with a cross section of 5.30 m. The price of 1 linear meter of such workmanship in the conditions of the Bistritsa mine is 12982 lv.

Results of the calculations made:

1/ Cost of mining (lv) = length of workings (m) x price per 1 linear meter of production (lv) = 8386372 lv.

2/ Sampling costs (lv) = number of samples x price per 1 sample (lv) = 19500 lv.

3/ General costs (lv) = mining costs (lv) + testing costs (lv) = 8405872 lv.

4/ Exploration cost of 1 ton of coal = total cost (lv) / stocks (t)

5/ At an annual yield of 100000 tons, stocks will be seized for 1 year: stocks (t) / annual yield (t) = years

6/ Revenues from the outlined block (lv) = reserves (t) x price for 1 t of coal (lv) = 23797397,75

7/ Costs of the outlined block (LV) = Reserves (t) x cost of 1t of coal = 87335110.45

8/ Losses from the development of the block (lv) = revenue (lv) – expenses=63517712.8

Table 5 Results of the calculations of the economic assessment of the deposit.

Average selling price, lv/t	Cost, lv/t	Losses, lv/t	Balance Stocks, mln.t	Avera ge losses, %	Extracta ble stocks, mln.t	Total value of the deposit, lv	Extractable value, lv
240,77	883,41	642,64	32	25	24	7704640000	5778480000

Table 6 Results of the cost estimation calculations for the production study project.

Costs 1 m of sampling, lv	Number of samples	Total sampling costs, lv	Length of mining works, m	Price per 1 m of mining	Mining galleries Costs
300	665	19500	646	12982	8386372
Total costs, lv	Exploration costs for 1 ton of coal, lv	Years of mining action	Revenue from the block lv	Costs of developing the unit, lv	Losses from unit development, lv
8405872	85046	1	23797397,75	87315110,45	63517712,97

Conclusions:

1. From the studies made on the quality of coal, the following is concluded:
2. Economic and environmental losses associated with spontaneous combustion of coal in the mine are unlikely, subject to safety instructions;
3. The ash content of coal is relatively high, which reduces their quality.
4. The Bistritsa mine works with subsidies from the state, which covers losses of 642.64 lv/t.

As a conclusion, we can use the statistical analyses published in the newspaper "Pari", issue 112, year. 3 (11) of June 1993, in which the following was published: The coal mined in our country has a higher cost compared to other countries, and for the most part it is of poor quality and low in calories. Imports under certain conditions provide cheaper hard coal. On the other hand, a decrease in their yield will reduce the number of people employed in this sector and, accordingly, will increase the already high unemployment. That is why the implementation of these forecasts is largely related to the policy that the government will undertake in the field of coal industry." In addition to the above, it can be noted that coal is a strategic raw material and the state is obliged to take care of this industry. In addition to all that has been said so far, it should be borne in mind that with the development of the currently operating deposits, the conservation of the site is avoided, which is also expensive, and thus a complex and complete depletion and reclamation is guaranteed.

Also, the proposed method of exploration without drilling, but only with operational exploration and technical furrow sampling is the best option under the created conditions and it makes sense to apply it during the exploitation of the field.

The mine ceased its activity by Decision No. 480 of 14.05.1996 of the Council of Ministers of the Republic of Bulgaria.

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11 CATALOGUE

of the known minerals in the Kyustendil region in M1:100 000, According to data from the National Geofund as of 1997 ("Maznikov group", Geology and Geophysics-AD)

Structure of the entries in the catalog: Catalog No; card sheet; Coordinates; name of the object; location; state of study; type of mineral; composition of ores; genesis (origin); scale; reports in the National Geofund, articles, monographs; Date of cataloguing.

222 K-34-57 Bosilegrad 42.5862 22.4569 Shatkovitsa 0/5 km SI from the village of Shatkovitsa indication metallic non-ferrous metals Au/pyrite/Cu/Pb hydrothermal M 1:100 000 IV-183 IV-1060 II-4 XV-1054 1994, 14.2.1996.

226 K-34-58 Radomir 42.485 22.6346 Sushitsa 1km NW from Sushitsa indication metallic ferrous metals Fe hydrothermal M 1:100 000 IV- 171 IV-1060 II-4, 15.12.1995.

229 K-34-58 Radomir 42.4621 22.6433 Zlogosh 300 m C from the village of Zlogosh metallic noble and non-ferrous metals Au/Cu hydrothermal/ vein M 1:100 000 IV-171/I-573/I-818 IV-1060 II-4 XV-1054 1994, 14.2.1996.

230 K-34-58 Radomir 42.4504 22.5827 Gorno Uyno 500m I-SI from the village of Gorno Uyno manifestation metallic non-ferrous metals Pb/Zn hydrothermal M 1:100 000 IV-171 IV-1060 II-4, 15.12.1995.

231 K-34-58 Radomir 42.4345 22.6023 Zdravkov dol 2/5 km SE from the village of Gorno Uyno manifestation metallic non-ferrous and precious metals Pb/Zn/Ag hydrothermal M 1:100 000 IV-171 IV-1060 II-4, 15.12.1995.

232 K-34-58 Radomir 42.4152 22.7058 Garbino 3 700 m SW from the village of Garbino occurrence metallic non-ferrous and precious metals Cu/Au/Ag/Pb/Zn hydrothermal/veined zones M 1:100 000 IV-171I-754 IV-1060 II-4, 15.12.1995.

233 K-34-58 Radomir 42.3997 22.7191 Garbino 2 700 m SW from the village of Garbino manifestation metallic non-ferrous and precious metals Cu/Au/Ag/Pb/Zn hydrothermal/stratiform M 1:100 000 IV-171I-754 IV-1060 II-4, 15.12.1995.

235 K-34-58 Radomir 42.421 22.7 Garbino 1 700 m SW from the village of Garbino manifestation metallic non-ferrous and precious metals Cu/Au/Ag/Pb/Zn hydrothermal/stratiform M 1:100 000 IV-171I-754 IV-1060 II-4, 15.12.1995.

237 K-34-58 Radomir 42.3387 22.6645 Sovolyano River Struma near the village of Sovolyano deposit metallic precious metals Au spilled M 1:100 000 Iliev Il. etc./1977/Geofond KG IV-1060 II-4, 15.12.1995.

245 K-34-58 Radomir 42.5048 22.6446 Dobri dol 1 km NW from the village of Dobri dol manifestation metallic ferrous metals Fe/Mn super genic M 1:100 000 IV-183 IV-1060 II-4, 15.12.1995.

324 K-34-69 Kriva Palanka 42.3256 22.4135 Padishte 2/9km NW from the village of Bobeshino manifestation metallic non-ferrous metals Pb/Zn hydrothermal M 1:100 000 Nikolaev Gr./N.Stefanov/Sl.Mankov/ 1972/VMGI NIS/dog.243/ IV-1060 II-6, 15.12.1995.

325 K-34-69 Kriva Palanka 42.2214 22.4772 Lebnitsa-zone 2 1/5 km S of the village of Gyueshevo metallic non-ferrous and precious metals Pb/Zn/Cu/Ag/Cd hydrothermal/ vein M 1:100 000 I-492/I-538/I- 804/Dzhatalov V./1980/Geofond KG IV-1060 II-6, 15.12.1995.

327 K-34-69 Kriva Palanka 42.3255 22.4155 Padishte 2/9 km NW from the village of Bobeshino indication non-metallic industrial minerals graphite metamorphic M 1:100 000 Nikolaev Gr./N.Stefanov/Sl.Mankov/ 1972/VMGI NIS/dog.243/ IV-1060 II-6, 15.12.1995.

329 K-34-69 Kriva Palanka 42.3179 22.4249 Nettle 1/5km NW from the village of Bobeshino manifestation metallic ferrous metals Fe hydrothermal M 1:100 000 Nikolaev Gr./N.Stefanov/Sl.Mankov/ 1972/VMGI NIS/dog.243/ IV-1060 II-6. 15.12.1995.

330 K-34-69 Kriva Palanka 42.318 22.4603 Gradishtenski dol 1/5 km I from the village of Bobeshino indication metallic non-ferrous and ferrous metals Cu/Fe/Mo hydrothermal M 1:100 000 Nikolaev Gr. /N.Stefanov/Sl.Mankov/ 1972/VMGI NIS/dog.243/ IV-1060 II-6, 15.12.1995.

331 K-34-69 Kriva Palanka 42.3148 22.4523 Leskov dol 0/8 km I from the village of Bobeshino indication metallic ferrous metals Fe hydrothermal M 1:100 000 Nikolaev Gr./N.Stefanov/Sl.Mankov/1972/VMGI NIS/dog.243/ IV-1060 II-6, 15.12.1995.

332 K-34-69 Kriva Palanka 42.3129 22.474 Portal neighborhood 430 m SE from the village of Bobeshino indication metallic ferrous metals Fe M 1:100 000 Zinoviev K./Zh.Stoychev/ As.Viktorov/L.Segmentski/ 1972/ Geofond KG IV-1060 II-6 15.12.1995

333 K-34-69 Kriva Palanka 42.308 22.4467 Kutugertsi 2/7 km I from the village of Bobeshino indication metallic non-ferrous metals Cu hydrothermal M 1:100 000 Zinoviev K. /Zh.Stoychev/As.Viktorov /L.Segmentski/ 1972/Geofond KG IV-1060 II-6, 15.12.1995.

334 K-34-69 Kriva Palanka 42.2846 22.4377 Rupite 2/9 km W from the village of Bobeshino indication metallic non-ferrous metals Pb/Zn M 1:100 000 Nikolaev Gr./N.Stefanov/Sl.Mankov/1972/VMGI NIS/dog.243/ IV-1060 II-6, 15.12.1995.

335 K-34-70 Kyustendil 42.2945 22.6822 Struma 1 km NW from Kyustendil deposit of metallic precious metals Au spilled M 1:100 000 I- 671/I-969 IV-1060 II-6, 15.12.1995.

336 K-34-70 Kyustendil 42.1942 22.9741 Vukovo 1/7 km I from the village of Vukovo indication metallic non-ferrous metals Cu M 1:100 000 IV-175 IV-1060 II-6, 15.12.1995.

337 K-34-70 Kyustendil 42.1902 22.526 Tsrni kamak 1/5 km W of mt. Men, manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 Zinoviev K. et al./ 1977 / Geofond KG IV-1060 II-6, 15.12.1995.

338 K-34-70 Kyustendil 42.1897 22.5157 Ruen 3/2 km S from Mt. Ruen, metallic deposit, non-ferrous metals Pb/Zn/Cu/Ag, hydrothermal/vein-injected zones M 1:100 000, I-620/Bonchev G./ 1905/1906 /BGD/Bonchev G./1922-1923/year. SU-FMF/Dimitrov Ts./ 1945 /year.OMGP /III/A/Yovchev J./Useful Fossils/ 1960/Technics/Boyanov B./1 IV-1060 II-6, 15.12.1995.

339 K-34-70 Kyustendil 42.1841 22.6221 Salmova Fountain 2/1 km SE of Kyunetsa Peak Occurrence metallic non-ferrous metals Cu/Mo hydrothermal M 1:100 000 IV-177 IV-1060 II-6, 15.12.1995.

340 K-34-70 Kyustendil 42.1825 22.5207 Shapka 2/5 km S from Mt. Ruen deposit: metallic non-ferrous metals Pb/Zn/Cu/Ag, hydrothermal/vein-injected zones M 1:100 000, I-426/I-492/VII-432/IV-177/I- 704/I-831/VII-379/I-705/Ts.Dimitrov/ 1945. A year on the otr. for Mining and Geological Research/III/A/Boyanov B. et al./Boyadzhiev St. IV-1060 II-

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341 K-34-70 Kyustendil 42.1743 22.7368 Kadrovitsa 4 km W from Kadrovitsa indication metallic non-ferrous metals Cu hydrothermal M 1:100 000 IV-177 IV-1060 II-6, 15.12.1995.

342 K-34-70 Kyustendil 42.1735 22.5167 Hat 2 1/7 km C from Ruen peak manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-1831 IV-1060 II-6, 15.12.1995.

344 K-34-70 Kyustendil 42.1733 22.6009 Delchevski dol 500 m S of mt. Dolnachuka manifestation metallic ferrous metals Mo/W hydrothermal M 1:100 000 Andreeva L./ Sl. Mankov/ 1972-73/Year. VMGI/XIX/ Mankov Sl./ 1974 IV Symposium JAGOD/ I/ 157-161 IV-1060 II-6, 15.12.1995.

347 K-34-70 Kyustendil 42.1643 22.553 Crna reka and from Shapka peak manifestation metallic non-ferrous metals Pb/Zn hydrothermal M 1:100 000 I-916/ G.Peshev/ K.Andonov/ Zh.Stoychev 1957-1967. Report on the results of geological mapping in M 1:5000/ with data from metalometers IV-1060 II-6, 15.12.1995.

348 K-34-70 Kyustendil 42.1634 22.6061 Kolibski dol 1 km SW from the village of Polegantsi manifestation metallic non-ferrous and ferrous metals Fe/Cu/Pb/Zn scarns M 1:100 000 I-372/ IV-269/ XV-244/ Ts.Dimitrov/ 1945 of the Department of Mining and Geological Studies / III / A / L. Andreeva / 1975. Yr. VMGI/XXI IV-1060 II-6, 15.12.1995.

349 K-34-70 Kyustendil 42.162 22.5925 Venin dol 2 km W of the village of Polegantsi manifestation of metallic non-ferrous and ferrous metals Fe/Cu/Pb/Zn scarns M 1:100 000 I-372/ IV-269/ XV-244/ Ts. Dimitrov/ 1945 of the Department of Mining and Geological Studies / III / A / L. Andreeva / 1975. Yr. VMGI/XXI IV-1060 II-6, 15.12.1995.

350 K-34-70 Kyustendil 42.1614 22.599 Mali lisichi dupki 1 /3 km W from the village of Polegantsi manifestation of metallic non-ferrous and ferrous metals Fe/Cu/Pb/Zn skarns M 1:100 000 I-372/ IV-269 / G.Bonchev / Petrographic notes for the Osogovo mountain with map M 1:26000/ Ts.Dimitrov/ 1945 of the Department of Mining and Geological Surveys IV-1060 II-6, 15.12.1995.

352 K-34-70 Kyustendil 42.1547 22.5591 Katar dere 4/1 km and from Ruen peak manifestation metallic non-ferrous metals Cu/Pb/Zn hydrothermal M 1:100 000 I-916/ G.Peshev/ K.Andonov/ Zh.Stoychev 1957-1967. Report on the results of geological mapping in M 1:5000/ with data from metal meters IV-1060 II-6, 15.12.1995.

354 K-34-70 Kyustendil 42.1513 22.8272 Smolichano 1 km NE from the village of Smolychano indication metallic non-ferrous metals Cu hydrothermal M 1:100 000 IV-177 IV-1060 II-6, 15.12.1995.

355 K-34-70 Kyustendil 42.1502 22.9606 Lumbeva mahala (Tsarishte) 1/8 km NW from the village of Tsarishte indication metallic non-ferrous metals Cu hydrothermal M 1:100 000 IV-175 IV-1060 II-6, 15.12.1995.

356 K-34-70 Kyustendil 42.1477 22.9407 Kraychova mahala 2/5 km NE from the village of Frolosh indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 IV-175 IV-1060 II-6, 15.12.1995.

357 K-34-70 Kyustendil 42.2729 22.538 Dolarska mahala 400 m I from the Letentsi area indication metallic ferrous metals Mo hydrothermal M 1:100 000 IV-177 IV-1060 II-6, 15.12.1995.

358 K-34-70 Kyustendil 42.1505 22.5533 Golyamiya dol 800 m from the mouth of Golyamia dol manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ G.Peshev/ K.Andonov/ Zh.Stoychev 1957-1967. Report on the results of geological mapping in M 1:5000/ with data from metal meters IV-1060 II-6, 15.12.1995.

359 K-34-70 Kyustendil 42.1492 22.5879 Ilovski dol 1 /8 km NW from the village of Vranyantsi manifestation of metallic non-ferrous and ferrous metals Fe/Pb/Zn scarns M 1:100 000 Ts.Dimitrov/ 1945. Annual of the Dept. Mining and Geological Surveys/ III/A/ I-372 IV-1060 II-6, 15.12.1995.

360 K-34-70 Kyustendil 42.1439 22.9187 Stanichina Krusha 1/6 km NE from the village of Frolosh indication metallic non-ferrous and ferrous metals Cu/Ni M 1:100 000 IV-175 IV-1060 II-6, 15.12.1995.

361 K-34-70 Kyustendil 42.1466 22.5658 Avalanche ravine 1/5 km W-NW of Zlatanska mahala indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ G.Peshev/ K.Andonov/ Zh.Stoychev 1957-1967. Report on the results of geological mapping in M 1:5000/ with data from metal meters IV-1060 II-6, 15.12.1995.

362 K-34-70 Kyustendil 42.1462 22.5712 Grob-I and Grob-II 800 m NW of Zlatanska mahala manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ G.Peshev/ K.Andonov/ Zh.Stoychev 1957-1967. Report on the results

of geological mapping in M 1:5000/ with data from metal meters IV-1060 II-6, 15.12.1995.

363 K-34-70 Kyustendil 42.1446 22.5911 Vranyantsi 400 m N from the village of Vranyantsi manifestation metallic non-ferrous and ferrous metals Fe/Cu/Pb/Zn skarns M 1:100 000 I-916/ I-823/ I-372/ Ts.Dimitrov/ 1945. Year of the Department of Mining and Geological Surveys / III/ A IV-1060 II-6, 15.12.1995.

364 K-34-70 Kyustendil 42.1442 22.5486 Yaneva livada 2 km E-NE from Baltashnitsa peak manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ G.Peshev/ K.Andonov/ Zh.Stoychev 1957-1967. Report on the results of geological mapping in M 1:5000/ with data from metal meters IV-1060 II-6, 15.12.1995.

365 K-34-70 Kyustendil 42.1444 22.5632 Gabera 2 km W-NW of Zlatanska mahala indication metallic ferrous metals Mo/W hydrothermal M 1:100 000 I-916 IV-1060 II-6, 15.12.1995.

366 K-34-70 Kyustendil 42.1407 22.9663 Tsarishte-I 550 m NW from the village of Tsarishte indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 IV-175 IV-1060 II-6 15.12.1995

367 K-34-70 Kyustendil 42.1416 22.5741 Vlashki dol 1 km W-NW from Zlatanska mahala manifestation of metallic non-ferrous and ferrous metals Fe/Cu/Pb/Zn skarns M 1:100 000 Ts.Dimitrov/ 1945. Annual Dept. Mining and Geological Surveys/ III/A/ I-372 IV-1060 II-6, 15.12.1995.

368 K-34-70 Kyustendil 42.2688 22.5896 Mirovo 1 km NW from the village of Mirovo manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-671/I-969 IV-1060 II-6, 15.12.1995.

369 K-34-70 Kyustendil 42.1405 22.5541 Lazaritsa 1/5 km W of Zlatanska mahala manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ I-372/ Ts.Dimitrov/ 1945. Annual Dept. Mining and Geological Surveys / III/A IV-1060 II-6 ,15.12.1995.

370 K-34-70 Kyustendil 42.1373 22.9902 Nurev rid ½ km SW of Boboshevo indication metallic non-ferrous metals Cu M 1:100 000 IV-175 IV-1060 II-6, 15.12.1995.

371 K-34-70 Kyustendil 42.1362 22.9607 Tsarishte-II 200 m W from the village of Tsarishte indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 IV-175 IV-1060 II-6, 15.12.1995.

372 K-34-70 Kyustendil 42.1392 22.5844 Petsovska mahala 100 m from Petsovska mahala manifestation metallic non-ferrous metals Pb/Zn/Cu skarnov M 1:100 000 I-704/ I-I916/ Sl. Mankov 1974/ IV symposium JAGOD/I/ Dimitrov/R./ B.Kolakovski/ Sl. Mankov. 1982. Year. SU/ 79/ Fig. Mankov 1984. Tertiary Ordnance IV-1060 II-6, 15.12.1995.

373 K-34-70 Kyustendil 42.1369 22.5616 Zhdrapanitsa-II 200 m S from the confluence of Zhdr.dol in the Eleshnitsa River manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ Munkov Sl/ 1974 IV Symposium IAGOD/ I/ 157-161/ I-704 IV-1060 II-6 15.12.1995.

374 K-34-70 Kyustendil 42.1335 22.579 Krumov kamak 500 m W of Eleshnitsa geological camp manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-704/ I-916 IV-1060 II-6 15.12.1995.

375 K-34-70 Kyustendil 42.1365 22.595 Lisin dol 100 m S from Petsovska. indication metallic ferrous metals Mo hydrothermal M 1:100 000 Andreeva L/ Sl Mankov/ 1972-73/Year.VMGI/XIX/ Mankov Sl/ 1974 IV symposium JAGOD/ I/ 157-161 IV-1060 II-6 15.12.1995.

376 K-34-70 Kyustendil 42.1305 22.5846 Zlatanska mahala 1/9 km from k.1813/8 - Zhdrapanitsa manifestation metallic non-ferrous metals Cu/Pb/Zn skarns M 1:100 000 I-704 IV-1060 II-6 15.12.1995.

377 K-34-70 Kyustendil 42.1336 22.8766 Zlatkova chuka ¾ km from the village of Frolash indication metallic industrial minerals pyrite hydrothermal M 1:100 000 Zagorchev Iv/ T.Kostadinov/ M.Ruseva/ L.Decheva/ Geological mapping in M 1:25000 in 1964 IV-1060 II-6 15.12.1995.

378 K-34-70 Kyustendil 42.1292 22.5779 Lagera 1/7 km at k.1813/8 - Zhdrapanitsa manifestation of metallic non-ferrous and ferrous metals Fe/Cu/Pb/Zn skarnov M 1:100 000 Andreeva L/ Sl Mankov/ 1972- 73 / Year.VMGI/XIX/ Monkov Sl/ 1974 IV symposium JAGOD/ I/ 157- 161 IV-1060 II-6 15.12.1995.

379 K-34-70 Kyustendil 42.2578 22.5798 Mirovo 800 m N from Vuchkovtsi area indication non-metallic industrial minerals feldspar/muscovite pegmatite M 1:100 000 IV-177 IV-1060 II-6 15.12.1995.

380 K-34-70 Kyustendil 42.1313 22.5953 Chukarevtsi 600 m SE from Petsovska mahala, indication metallic ferrous metals Mo/W hydrothermal M 1:100 000 Andreeva L/ Sl Mankov/ 1972-73 / Year VMGI / XIX / Mankov Sl/ 1974 IV symposium JAGOD/ I/ 157- 161/ I-704 IV-1060 II-6 15.12.1995.

381 K-34-70 Kyustendil 42.1287 22.9906 Spinning stone 1/7 km SW of Boboshevo manifestation metallic ferrous metals Mo/W M 1:100 000 IV- 175 IV-1060 II-6 15.12.1995

382 K-34-70 Kyustendil 42.1303 22.5844 The landslide 1 km NW from Petsovska mahala, Manifestation of metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 Andreeva L/ Sl Mankov/ 1972- 73 / Year VMGI / XIX / Mankov Sl/ 1974 IV symposium JAGOD/ I/ 157- 161/ I-916 IV-1060 II-6 15.12.1995.

383 K-34-70 Kyustendil 42.1277 22.5945 Zlatna ribka 1 km W of Petsovska mahala, indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-823 IV-1060 II-6 15.12.1995

384 K-34-70 Kyustendil 42.1273 22.5897 Pchelina on the right bank of Petsovski dol and Eleshnitsa River manifestation metallic ferrous metals Mo/W hydrothermal M 1:100 000 Andreeva L/ Sl Mankov/ 1972-73/Year.VMGI/XIX/ Munkov Sl/ 1974 IV Symposium JAGOD/ I/ 157-161/ I-916 IV-1060 II-6 15.12.1995.

385 K-34-70 Kyustendil 42.1253 22.5643 Zhdrapanitsa-I 700 m I from Mt. Zhdrapanitsa manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 Andreeva L/ Sl Mankov/ 1972- 73/Year.VMGI/XIX/ Munkov Sl/ 1974 IV symposium JAGOD/ I/ 157- 161 IV-1060 II-6 15.12.1995.

387 K-34-70 Kyustendil 42.1192 22.6679 Savoyski 500 m NW from the village of Savoyski indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 IV-177 IV-1060 II-6 15.12.1995.

388 K-34-70 Kyustendil 42.1184 22.5755 Prosechenik 800 m NW of Kutsolintsa peak manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 I-916/ Mankov Sl/ 1974 IV Symposium IAGOD/ I/ 157-161 IV-1060 II-6 15.12.1995.

389 K-34-70 Kyustendil 42.1103 22.6523 Chekanets 1/1 km NW of the Double Indication: non-metallic industrial minerals, fluorite hydrothermal M 1:100 000 Zagorchev/ I./M.Reseva/ 1982/ Geologica Balcanica/ 12/3 IV-1060 II-6 15.12.1995.

390 K-34-70 Kyustendil 42.2524 22.5548 Resentsi 500 m S of Resentsi Occurrence metallic ferrous metals Fe/pyrite hydrothermal M 1:100 000 IV-177 IV-1060 II-6 15.12.1995.

391 K-34-70 Kyustendil 42.0972 22.6735 Zidintsi 100 m E from the village of Zidintsi indication non-metallic industrial minerals fluorite hydrothermal M 1:100 000 Zagorchev/ I./M.Reseva/ 1982/ Geologica Balcanica/ 12/3 IV-1060 II-6 15.12.1995.

392 K-34-70 Kyustendil 42.0954 22.7864 Vuchkovtsi 1km W-NW from Tutkavtsi Indication metallic non-ferrous metals Cu contact-metasomatic-hydrothermal M 1:100 000 IV-177 IV-1060 II-6 15.12.1995

393 K-34-70 Kyustendil 42.0732 22.8462 Tsarvaritsa 500 m E from the village of Tsarvaritsa indication metallic non-ferrous metals Cu hydrothermal M 1:100 000 IV-177 IV-1060 II-6 15.12.1995.

395 K-34-70 Kyustendil 42.2089 22.9052 Pastuh 100 m NE from the village of Pastuh indication metallic non-ferrous metals Cu/Ni M 1:100 000 IV-175 IV- 1060 II-6 15.12.1995.

396 K-34-70 Kyustendil 42.1999 22.7294 Searched 1/6 km I from v. Tarsino indication metallic non-ferrous metals Cu hydrothermal M 1:100 000 IV-177 IV-1060 II-6 15.12.1995.

397 K-34-70 Kyustendil 42.1999 22.5323 Yalovarnik-Zastavata-Bazovinyak 900 m NW of Choveceto peak manifestation metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 Zinoviev K. et al./1977/Geofond KG IV-1060 II-6 15.12.1995.

399 K-34-71 Blagoevgrad 42.1784 23.1325 Badino 2 km E from the village of Bdino manifestation metallic non-ferrous metals Cu hydrothermal M 1:100 000 V I258 IV-1060 II-7 15.12.1995

400 K-34-71 Blagoevgrad 42.174 23.3119 Urdini Lakes 100 m E from elevation 2592 m Occurrence non-metallic industrial minerals muscovite pegmatite M 1:100 000 IV--81/II-216 IV-1060 II-7 15.12.1995.

401 K-34-71 Blagoevgrad 42.171 23.2982 Urdini Lakes Immediately and from elevation 2592 m Occurrence Non-Metallic Industrial Minerals Talc/Asbestos Hydrothermal M 1:100 000 IV-81 IV-1060 II-7 15.12.1995.

402 K-34-71 Blagoevgrad 42.1703 23.362 Elena Lakes S-SW of Malyovitsa Peak_Manifestation Non-Metallic Industrial Minerals Talc/Asbestos Hydrothermal M 1:100 000 IV-81 IV-1060 II-7 15.12.1995.

403 K-34-71 Blagoevgrad 42.1587 23.3245 Drushlyovitsa 3 km N from Rila Monastery manifestation metallic ferrous metals Fe skarn M 1:100 000 V-258/IV-81 IV-1060 II-7 15.12.1995.

405 K-34-71 Blagoevgrad 42.1445 23.197 Padala 100m N-NE from the village of Padala indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 V-258/IV-81 IV-1060 II-7 15.12.1995.

406 K-34-71 Blagoevgrad 42.1423 23.3474 Brichebor NE from Rila Monastery indication metallic non-ferrous metals pyrite/pyrrhotite/Cu igneous M 1:100 000 V-258 IV-1060 II-7 15.12.1995.

407 K-34-71 Blagoevgrad 42.1396 23.3446 Rila Monastery 300 m C from Rila Monastery Indication metallic non-ferrous metals Cu M 1:100 000 V-258 IV-1060 II-7 15.12.1995.

408 K-34-71 Blagoevgrad 42.1414 23.0024 Boboshevo 1 km S of Boboshevo Metallic Non-Ferrous Metals Cu M 1:100 000 V-258/IV-81/I- 590 IV-1060 II-7 15.12.1995.

409 K-34-71 Blagoevgrad 42.311 23.3098 Saparevo 1/5 km NE from the village of Saparevo occurrence non-metallic industrial minerals muscovite/pegmatite M 1:100000 IV-89 IV-1060 II-7 15.12.1995.

410 K-34-71 Blagoevgrad 42.1364 23.2196 Pastra 1/5 km N from the village of Pastra indication metallic ferrous metals pyrite/Mo hydrothermal M 1:100 000 V-258/IV-81 IV-1060 II-7 15.12.1995.

411 K-34-71 Blagoevgrad 42.1341 23.2383 Pastra 2 km NE from the village of Pastra deposit non-metallic industrial minerals muscovite pegmatite M 1:100 000 IV-81/ II-216 IV-1060 II-7 15.12.1995.

412 K-34-71 Blagoevgrad 42.1278 23.2599 Zhelyu Demirevski 400 m I from the station of the same name manifestation metallic non-ferrous metals Cu M 1:100 000 V-2258 IV-1060 II-7 15.12.1995.

413 K-34-71 Blagoevgrad 42.0947 23.1145 Stob 100m E from the village of Stob manifestation of non-metallic industrial minerals muscovite pegmatite M 1:100 000 II-216///IV-81 IV-1060 II-7 15.12.1995.

415 K-34-71 Blagoevgrad 42.0833 23.3901 Radivichna River 1 km before the confluence of the Radichka River into the Iliina River Indication metallic industrial minerals pyrite M 1:100 000 V-258 IV-1060 II-7 15.12.1995.

421 K-34-71 Blagoevgrad 42.2145 23.0932 Sapareva banya 0/5km from Govedartsi indication metallic non-ferrous metals Pb/Zn/Cu hydrothermal M 1:100 000 IV-89 IV-1060 II-7 15.12.1995.

422 K-34-71 Blagoevgrad 42.212 23.1445 Bistritsa 4 km SW from the village of Bistritsa indication metallic industrial minerals pyrite hydrothermal M 1:100 000 IV-81 IV-1060 II-7 15.12.1995.

424 K-34-71 Blagoevgrad 42.1964 23.3188 Bliznaka Lake 100 m S of Bliznaka Lake Manifestation of non-metallic industrial minerals muscovite pegmatite M 1:100 000 II-216 IV-1060 II-7 15.12.1995.

426 K-34-71 Blagoevgrad 42.1815 23.1084 Badino 500 m N from the village of Bdino indication metallic non-ferrous metals Mo/Pb/Zn/Cu hydrothermal M 1:100 000 I-850 IV-1060 II-7 15.12.1995.

7563 42.3955 22.6916 Dragovishtitsa N-NW from Kyustendil Deposit of metallic precious metals Au spilled M 1:500 000 Final report on assignment: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7663 42.578 22.5688 Sredorek (Sredorechka River) NW from the town of Kyustendil manifestation metallic precious metals Au hydrothermal/ vein M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7664 42.548 22.633 Treklyano 1 (Treklyanska River) NW from the town of Kyustendil manifestation of metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the Market Economy/1994. Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7665 42.5457 22.6506 Treklyano 2 (Treklyanska River) NW from the town of Kyustendil manifestation metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7666 42.5141 22.5947 Gorni Koriten (Uynestitsa River) NW from the town of Kyustendil manifestation of metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7667 42.5056 22.6231 Gorno Uyno (Zlogosh - 1) NW from the town of Kyustendil manifestation of metallic precious metals Au spilled M 1:500000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7668 42.4823 22.6175 Gorno Uyno (Zlogosh - 2) NW from the town of Kyustendil manifestation of metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7669 42.4912 22.5969 Dolni Koriten (Uynestitsa River) NW from Kyustendil manifestation metallic precious metals Au spilled M 1:500 000 Final report on assignment: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7670 42.461 22.595 Gorno Uyno (Uynestitsa River) NW from the town of Kyustendil manifestation of metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7671 42.4446 22.6303 Poletintsi NW from Kyustendil manifestation metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market Economics/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7672 42.3697 22.6649 Sovolyano (Bistritsa River) NW from the town of Kyustendil manifestation of metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996..

7673 42.3605 22.6937 Skryniano (Bistritsa River) NW from Kyustendil manifestation metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy / 1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

7674 42.4302 22.7276 Shagava N from the town of Kyustendil manifestation metallic precious metals Au hydrothermal/ vein-injected zones M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy/1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

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7678 42.2404 23.0174 Kamenyak SW from the town of Dupnitsa manifestation of metallic precious metals Au spilled M 1:500 000 Final report on the task: The mineral resource base of Bulgaria and opportunities for its optimal use in the conditions of the market economy / 1994 Auto. P. Vassilev/ A. Radkov and others. XV-1054 1994 28.3.1996.

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12 FILE

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Minerals, Energy Resources, Soils and Waters in Kyustendil Region, South Europe

Kyustendil region has a rich history in the extraction of gold, silver, copper, zinc, iron, tin, coal and mineral waters. Data and considerations for the search for polymetallic, tin, mercury, tungsten-molybdenum, ores of rare and scattered elements and fluorite ores, as well as coal, oil, rock cladding and building materials, raw materials for ceramics and precious stones in the region of Kyustendil are presented. The history of prospecting and extraction of ores and coal in the region is traced, indicating the benefits and harms of state administration in the process of assimilation of raw materials. It is found that Pautalia and Velbazhd were mining centers in antiquity and the Middle Ages with the management of resources by local authorities and structures. The Kyustendil region flourished in epochs of intensive mining and metallurgy. It is proposed that these processes and resources be effectively controlled and managed by a municipal development bank and a geological department of the municipality.

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