

## THE BIRTH OF THE ESTONIAN OIL SHALE INDUSTRY – LINKS TO RUSSIA AND SCOTLAND

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**Abstract.** *Oil shale is considered the most important natural resource of Estonia and its role in energy production and chemical industry has been pointed out in numerous papers. But there are no special publications about the history of the Estonian oil shale industry in English. This article tries to fulfil the gap relying on numerous archival documents and literature sources which have remained out of the attention of scientists up till now. It follows from the article that without the studies carried out by Russian researchers in 1916–1920 the Estonian oil shale industry may not have been born. Using the results of Russian investigators, the Estonians hoped to set up their own oil shale industry applying Scottish experience. This hope failed, however, and thus the Estonians had to elaborate their own methods for the development of oil shale chemistry.*

**Keywords:** *history of the Estonian oil shale industry, the birth of the Russian oil shale industry, World War I, Nikolay Pogrebov, Henry von Winkler, Märt Raud.*

### 1. Oil shale studies in the province of Estonia before 1916

The areas of the present-day Republic of Estonia belonged to the Russian empire as the provinces of Estonia and Livonia in 1721–1918. The discovery of oil shale in 1788 in the territory of the Kohala estate in the northern part of the province of Estonia was for the first time reported at a meeting of the St Petersburg Free Economic Society on 28 March 1789. The first information about that discovery appeared in the scientific literature in 1791 [1] but did not cause any reaction in the agricultural province of Estonia. On the contrary, this fact was forgotten until 1916 [2: 292, footnote 2]. At the close of the 18th century, Estonia lacked any kind of industry and there were not

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any universities or scientists and engineers who would have been interested in that discovery.

It was only in 1838 that the information about the second discovery of oil shale in the village of Vanamõisa belonging to the Kohala estate reached St Petersburg and attracted the attention of the Russian Minister of Finance. To have a new local combustion material so close to St Petersburg, would have been favourable for the empire's industrial development. The Baltic German Gregor von Helmersen, known as a specialist in geological surveying, was sent to carry out studies in oil shale [3: 57]. Helmersen noted that it would be quite useful to local people to use oil shale (he called it *brauner Brandschiefer*; Russian: *горючий сланец*) as a fuel, although it could not be compared with higher quality English coal used in St Petersburg [3: 73]. After Helmersen's expedition, the Russian authorities lost their interest in oil shale.

In 1850–1857, the Baltic German geologist Friedrich Schmidt criss-crossed the whole area of today's Estonia. He was lucky as at the beginning of the 1850s agriculture began to be developed more intensively in the province of Estonia and estate owners had started land drainage. In comparison with the period when Helmersen performed his studies and there were very few draining ditches, the ditches dug in the 1850s enabled the establishment of the presence of oil shale (not detectable from the surface) in different regions of the province of Estonia. Oil shale was found in the area from Haljala to Kohtla [4]. Schmidt gave the beds containing oil shale (his German versions: *Brandschiefer* or *rothbrauner bituminöser Mergel*) the name *Kuckers stage* [5: 415] which was derived from the name of the manor Kuckers (Estonian name Kukruse) in whose territory the draining ditch which exposed the layers of oil shale was situated. This name of Estonian oil shale spread through Schmidt to German and Russian scientific literature [6, 7: 28]. In 1916, however, the name of Estonian oil shale acquired a new scientific content when inspired by the organic component found in it and identified as sapropel (a kind of kerogen) the Russian palaeobotanist Mikhail Zaleskiy renamed it *kukersite* [8].

A new step in the study of the chemical composition of oil shale was made at the end of the 1860s when the Russian chemist Aleksandr Shamarin analysed the composition and chemical properties of Kukruse oil shale. He concluded that it would be most rational to use Estonian oil shale for extracting gas and as a fuel [9: 46].

All the scientists and engineers who performed tests with oil shale, from the 18<sup>th</sup> to the 20<sup>th</sup> century, considered it valuable as a combustible [1, 3, 7, 9, 10]. But, Schmidt wrote in 1881 that it would be wonderful to receive heating oil and lubricating oil from oil shale, but its exploitation would prove unprofitable as the layer richest in oil appeared to be thin in the draining ditch of Kukruse [7: 29]. The Russian Geological Committee (performing geological surveys of natural resources in the empire) set up in

St Petersburg, at the Ministry of State Property, in 1882 shared the same opinion.

At the end of the first decade of the 20<sup>th</sup> century, an attempt was made to start shale oil extracting in Estonia, but it failed [11: 29–32]. For the distillation of oil shale a special technology had to be elaborated. The technologies used in other countries (e.g., Scotland and Germany) were unknown in Russia. The absence of respective references in the writings on Estonian oil shale proves that [3, 7, 9, 10]. Besides, mining required certain preparations, like the drainage of the great amount of groundwater from the oil shale outcrop area around the village of Järve (today the territory of the town of Kohtla-Järve). The labour resource was also scanty in sparsely populated Northeast Estonia. So it was obvious that the foundation of oil shale industry was feasible only with the support of the government or to big private companies able to bear the great financial duty. Such companies, however, were not interested in oil shale and thus the knowledge of the great potential of oil shale was preserved only in the minds of a few engineers and researchers, not in wide public. In the Russian society, oil shale was a totally unknown combustion material still in 1915.

## **2. Studies in the exploitation of Estonian oil shale in Russia in 1916–1917**

Due to World War I, beginning in 1914, the Russian empire (mainly consuming coal) lost a very important coal and metal importer – Germany. That had to be compensated with the import of respective supplies from Russia's allies (e.g. Great Britain), or through more intensive exploitation of its own coal resources (in Donbas). Although Donbas increased the production of coal, the inefficient Russian railway system was unable to provide consumers with sufficient amounts of it. The situation became especially critical in 1916 after the very severe winter of 1915/1916. In order to antedate possible heating problems in the winter of 1916/1917, in the first place, in the largest industrial centres such as Petrograd and Moscow, several institutions (Central War Industries Committee (Russian: *Центральный Военно-Промышленный комитет*) and Extraordinary Committee for Fuels (Russian: *Особое совещание по топливу*)) were mobilised to deal with the problem.

It appears from the literature that Estonian oil shale was for the first time under discussion at the meeting of the Petrograd Main Committee for Fuels in January 1916 already [12: 105]. From then, the idea of oil shale as an alternative combustible came on the agenda. The Petrograd Main Committee for Fuels asked the Geological Committee to study the problem. The Geological Committee, in turn, asked its librarian and geologist Nikolay Pogrebov to search out literature concerning Estonian oil shale. Pogrebov reported about his results at the meetings of the Petrograd Main Committee for Fuels

in March 1916. His studies indicated that the scientists and engineers who had studied Estonian oil shale had estimated the thickness of the shale layer in artificial crosscuts (draining ditches and wells) only. As these were not deep enough to cross the shale layers, there arose a hope that the deeper shale layer could be considerably thicker and thus the resources considerably larger than Schmidt had supposed to be. Relying on the information presented by Pogrebov, the Petrograd Main Committee for Fuels decided to start studies on site [11: 35].

On 20 April 1916, the Petrograd Main Committee for Fuels already applied to the Geological Committee for an approval to send Pogrebov to Estonia to study oil shale. For these studies, 4000 roubles were given with arguments that “/.../ oil shale can perform a certain [underlined in the original] role in supplying the Petrograd region with combustion material in the period of the fuel crisis.” [13].

The first trip of Pogrebov to Estonia lasted for one and a half weeks and as oil shale seemed to be perspective, the Petrograd Main Committee for Fuels set up a special department for oil shale research subordinated to the main committee, with Aleksey Lomshakov, professor of the Petrograd Institute of Technology, at the head of it. The Central War Industries Committee also decided to support the studies, giving 15 000 roubles for digging a sufficient amount of oil shale for tests [12: 105]. The geological survey was performed from July to November 1916 under the guidance of Pogrebov. The studies were mainly carried out on the spot by one of the members of the expedition – the geologist Pavel Krutikov. The surveying was started in the area of the Kukruse manor in July. Then the expedition moved on – to the Järve village. The thickness of oil shale layers was particularly impressive (2.71 m) in the area between the Järve rural office and the Pavandu inn. It was decided to start immediately experimental mining of oil shale and the digging of a drainage ditch near the Pavandu inn. From the second half of June till November 640–690 tons of oil shale (22 wagons) was mined for tests [2: 305].

Oil shale experiments were carried out in different laboratories of the Russian empire. First experiments were successful and proved that oil shale was suitable to be used as a combustible without a special need for rebuilding factory and cement furnaces, as well as in domestic fireplaces. Using (dry) distillation, oil shale gas and crude oil could be extracted from the shale [12: 108–109].

Such information was very positive for Petrograd. On 3 January 1917, the plan for oil shale mining compiled by Lomshakov was presented to the Extraordinary Committee for Fuels and on the very same day Count Vsevolod Shakhovskoy, Minister of Trade and Industry, presented it to Tsar Nicholas II. In the report Shakhovskoy pointed out that a new branch of industry which could be set up in the area where oil shale was found would enable to provide Petrograd and Tallinn regions, at least partly, with locally produced oils and high-quality fuel [14]. A plan according to which the

investment of 1.2 million roubles was indicated as the rent of land for opencast mining and for employing 420 workers to mine 6 million poods (98 thousand tons) of oil shale per year was added to the report [15]. Thus, oil shale mining had become the question of state priority.

The idea of founding an oil shale industry in Estonia looked promising; however, the military and political situation in Russia had cardinally changed by the beginning of 1917 (February Revolution, the Emperor had vacated the throne, the provisional government had seized power). On 13 February 1917, the Council of Ministers approved the sum of 1.2 million roubles for the start of oil shale mining. Land was bought or rented in different villages of Northeast Estonia (314,8 ha).

It was not simple to start mining because of the complicated political situation and more and more bankrupting Russia. According to the plan in spring 1917, 35–36 million poods (0,573–0,590 million tons) of oil shale had to be mined per year [16: 74]. In the summer of 1917, about 500 workers (partly prisoners of war) took part in the building of the Järve state mine. Simultaneously with the mining in the state-owned Järve mine, digging was started north of the Järve village and at Kukruse by the companies Mutchnik & Co and Pavel Boeckel & Co from Petrograd, respectively (Fig. 1). These companies had specially been founded for mining oil shale.

As the political and military situation had become catastrophic in Russia by October 1917, the representatives of the Extraordinary Committee for Fuels, the mining department and the military committee convened for an urgent meeting in Petrograd. The participants in the meeting had to admit that the very “great expectations” in 1917 to fulfil Petrograd’s need for fuels through oil shale mining were “greatly overestimated”. It was also conceded that intensive production would not be possible before 1918. In spite of that and the problematic state financing of mining, the goal was set up to mine 500–600 thousand poods (8200–9800 tons) of oil shale in 1917. It was also admitted that the situation in the front was critical and thus the mine could pass over to Germans. That is why it was decided to send the geological mission east of the Narva river, the region of the Veimarn railway station in the county of Yamburg (Kingsissepp today) [17].

The coming to the power of Bolsheviks in Russia in November 1917 did not bring along a positive change in oil shale mining and research. The first thing to happen was the cease of financing. Germans conquered Estonia where oil shale was discovered. Regardless of very complicated conditions, the Russian engineers still kept oil shale research in process. Tests with oil shale were continued at the gas factory of the Petrograd Polytechnic Institute and analysis of oil shale industries in different European countries was started. Russians used as an example the technology of the Scottish oil shale industry [18].

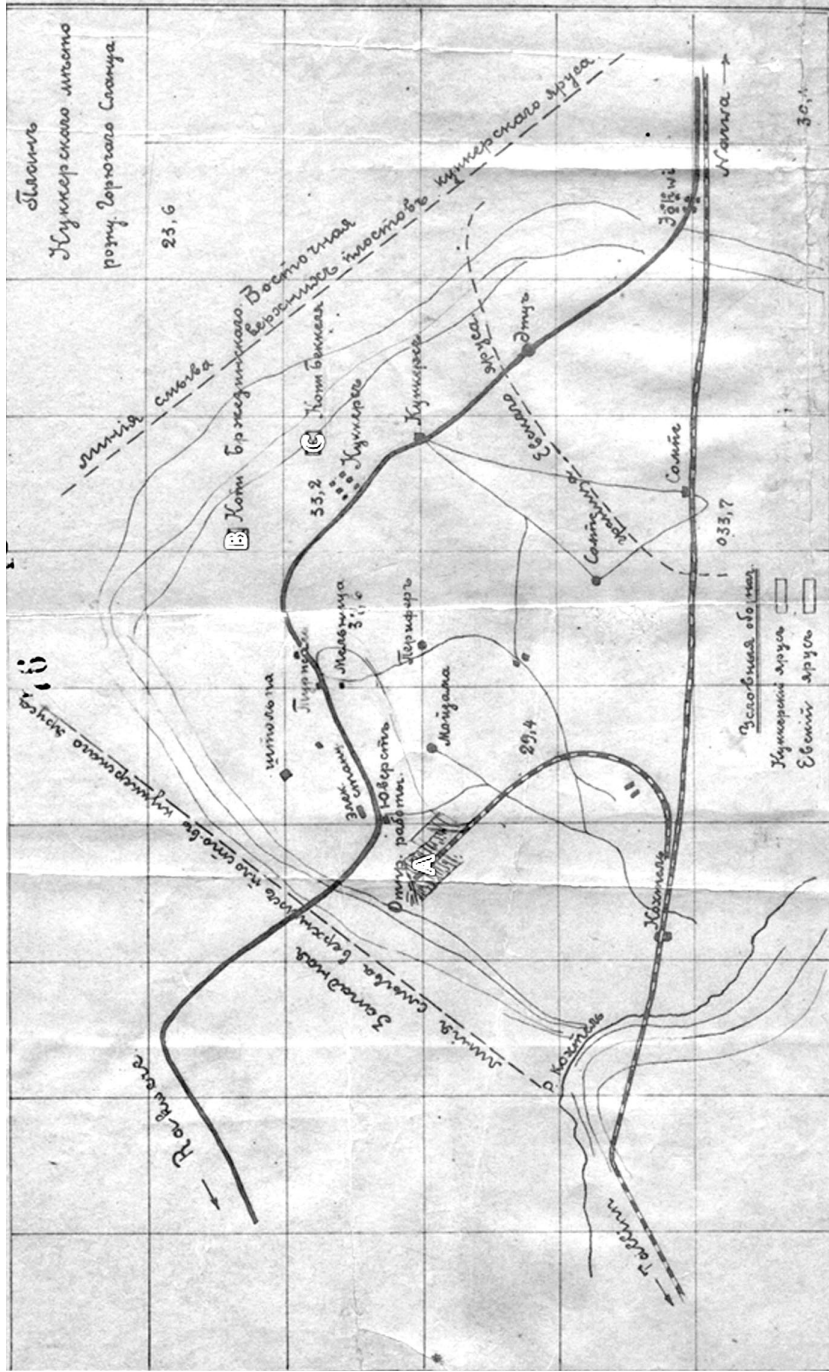


Fig. 1. The location of oil shale mines in Estonia on 25 November 1918. A) Järve state oil shale mine. Private mines: B) Mutchnik&Co, C) Pavel Boeckel&Co [Source: Estonian State Archive, 73-1-1261, sh. 75v].

### 3. Estonians and their relations with oil shale research in Russia until November 1918

Before the summer of 1916, the Estonian public knew little about oil shale and the possibilities of its use. Estonians had no experience in dry distillation and the chemical study of oil shale. That kind of information was at the disposal of Russian scientists and engineers. The possibility of taking part in the foundation of oil shale industry, in the first place, depended on the Estonians who in some way had participated in oil shale research. One such person in Estonia was the Baltic German Henry von Winkler (Fig. 2), chemist, head of a bacteriological laboratory in Tallinn. He can be considered the pioneer of Estonian oil shale chemistry. Winkler had extracted crude oil from shale since the spring of 1916 already. On the initiative of the Extraordinary Committee for Fuels, the municipality of Tallinn financed his studies for the establishment of oil shale resources in the Tallinn region from autumn 1916 [19: 91]. By the order of Lomshakov, the bacteriological laboratory headed by Winkler studied the chemical composition of the crude oil received at low-temperature distillation of oil shale [2: 319]. All these studies of Estonian oil shale, which Winkler continued in 1919 and 1920, too [19: 68–95], made him an advocate of oil shale research in Estonia. Thus it is quite self-evident that he later devoted his life to oil shale chemistry, the most important result of which was the publication of the encyclopaedic monograph on Estonian oil shale [20].

The other person to be mentioned in connection with oil shale is the Estonian engineer Märt Raud, who lived in Petrograd (Fig. 3). Differently from Winkler, he had some political influence in in-



Fig. 2. Henry von Winkler (1870–1947), the pioneer of Estonian oil shale chemistry [Source: Maria Limberg's personal archive in Berlin].



Fig. 2. Märt Raud (1878–1951(?)), founder of Estonian oil shale industry [Source: Estonian Literary Museum Neg. B-181-1319].

dependent Estonia. As it follows from the archival documents, Pogrebov should certainly be given credit for the circumstance that in March 1918 Raud began to examine literature on oil shale and became a convinced supporter of its use [11: 284]. Even more important than the literature Raud had read was the opportunity of participating in the meetings organized by engineers in Petrograd, in which the results of Estonian oil shale research and perspectives of future oil shale industry were also touched upon. At these meetings Raud understood that in order to set up oil shale industry, the first thing to do was to construct a good furnace using oil shale and design a suitable retort for extracting shale oil [21: 35–36]. In this respect, Russians hoped to make use of the experience of the Scottish oil shale industry.

#### **4. The birth of the Estonian oil shale industry**

When in August 1918 Raud moved from Soviet Russia to German-occupied Estonia, it appeared that the occupation government had declared oil shale a strategic resource. According to the assessment of German geologists, mining in the area already surveyed by Russians was complicated because of the high levels of groundwater making mining very expensive. Raud, differently from the Germans, believed in the profitability and practicability of oil shale. To prove his views, he needed the surveying results obtained by Russians. Although residing himself in Estonia, via his contacts in Petrograd Raud received all the data he needed.

On 25 November 1918, on behalf of the Provisional Government of the Republic of Estonia, Raud took over the Järve mine from the Germans, but due to the winter of 1918/1919 and the short-time Bolshevik occupation in Northeast Estonia, the start of mining in appropriated mines was postponed until 5 May 1919 [21: 12–14]. Because of the civil war in Russia and battles also going on in the territory of Estonia, there was a great probability that fuel crisis, which continued in Petrograd, would reach Estonia in the winter of 1919/1920. Raud, like also Russian engineers, stated that oil shale was the main possibility for Estonia to cope with that crisis. The crisis presented an opportunity to introduce oil shale as a new combustible to the public, the government and the parliament, not only through the press. Raud succeeded in doing that and in 1919, already, the local combustible material unknown to people until then, was accepted as a viable fuel [21: 104–105]. On his initiative, the oil shale resources in Estonia were transferred into state ownership.

Like Russian researchers, Raud was convinced that the oil shale chemical industry could be founded making use of the Scottish oil shale technology. In that context, in November 1918, he persuaded the Estonian Provisional Government to urge the Estonian ambassador in London to apply to the management of the Scottish oil shale industry [22]. Since yet in 1919, no foreign country had recognized Estonia as an independent republic, the



attempts of the Estonian representative in Scotland to obtain information about the Scottish oil shale industry and gain the agreement to design a retort for Estonia bore no success. As Raud did not want to waste time in setting up oil shale industry and conducting tests in Estonia was deemed too expensive, on his insistence, in May 1919, the Provisional Government of Estonia decided to send two scientists to Scotland with the aim to learn oil shale distillation methods first hand. But there was only one oil shale chemist to be sent to England – Paul Kogerman. In England, Kogerman conducted thermal decomposition tests with Estonian oil shale in collaboration with Jaan Kopvillem, Secretary of the Embassy of the Estonian Provisional Government in London, an expert chemist who was later devoted to Estonian oil shale chemistry. Visits to oil shale plants very soon proved that the Estonian and Scottish oil shales were chemically not as similar as assumed on the basis of studies of Russian scientists [11: 291].

Since the hope that the Scottish oil shale technology would help to jump-start the Estonian oil shale industry had to be given up, it was decided to introduce governmental concessions and, in addition to Estonian citizens, give a chance to foreign entrepreneurs to mine and refine Estonian kukersite. Thus, in the 1920s, side by side with local factories, the developers of oil shale industries also included the British, Germans and Swedes. Since it was ascertained that by its properties kukersite resembled more closely brown coal found in Germany, the first national experimental oil shale distillation retort was set up in 1921 on the basis of German technology (Pintsch's generator). The same technology was used in the first industrial oil shale distillation plant of Estonia opened in 1924 [21: 72–76]. Thus, the Estonians had taken a big step on as compared to that achieved by the Russians. By the end of the 1920s, as a result of intensive oil shale studies and the prioritizing of shale oil refining technologies at the state level, Estonia had become the leading country in the world in the field of oil shale research and shale oil chemistry.

## **5. Conclusions**

According to the written sources available today, the first article about oil shale in the province of Estonia was published in 1791. Beginning with the 1870s, more information began to accumulate about the heating value of oil shale. But in the Russian empire, there was insufficient state and private interest in mining oil shale because coal – which was cheap and whose technology was known – was used as the main energy source.

In that perspective, something extraordinary had to happen in the Russian empire in order oil shale would make its way as a useful fuel into the minds of state authorities and the wider public. World War I and the fuel deficit in Petrograd just served such a purpose as it reminded to the authorities Estonian kukersite not far from Petrograd and just in the vicinity of the

Baltic railway line. The Main Committee for Fuels of Petrograd considered it worth carrying out a survey of the oil shale bedding in Estonia. Tests performed with oil shale proved to be successful especially keeping in view the critical need for fuel. With some concessions, kukersite was suitable to be used as a combustible in the factories designed to work on coal, as well as in domestic fireplaces and steam boilers. And what was even more important – tests in laboratories confirmed that shale oil and gas were invaluable raw materials for the chemical industry. The complicated political situation in Russia in 1917 had its effect on oil shale mining in Estonia. Although the mine was ready in spring 1917, full-scale mining operations did not start.

The Estonian civil engineer Märt Raud had an opportunity of applying the experience of the Russian oil shale studies in the already independent Republic of Estonia. Although Estonia had formally become independent on 24 February 1918 and was in war with Soviet Russia, it did not prevent Raud from procuring most recent information of Russians about Estonian oil shale and its usage in 1918 and in 1920 as it was important to Russian scientists and engineers that oil shale would find its place among other industrial mineral resources. Even though the application of Scottish technology in oil shale industry failed, the Russian material was, nevertheless, crucial. The studies carried out by Russians and their investments in the infrastructure of the Järve mine significantly contributed to the creation of the Estonian oil shale industry. The process of the development of the oil shale industry in independent Estonia in the 1920s changed fundamentally, from the root level, the industrial life of Northeast Estonia in the first place, but also of the whole of Estonia. Oil shale secured the energy independence to Estonia which aspect is continuously topical in Estonian (economic) policy also nowadays.

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### REFERENCES

1. Anonymous. About the burning soil in the province of Tallinn. *Auswahl ökonomischer Abhandlungen, welche die freie ökonomische Gesellschaft in St. Petersburg in deutscher Sprache erhalten hat*, 1791, **3**, 330–331 (in German).
2. Pogrebov, N. Estonian oil shales. *Estestvennye proizvoditel'nye sily Rossii. Poleznye iskopaemye, sostavlen Geologicheskim Komitetom*, 1919, **4**(20), 288–323 (in Russian).

3. Helmersen, G. von. On the bituminous shale and a newly detected combustible rock formation in the Province of Estonia, supplemented by remarks on some geological phenomena of modern times. *Bulletin scientifique publié par l'Académie Impériale des Sciences de Saint-Petersbourg*, 1838, **5**(4–5), 56–73 (in German).
4. Schmidt, F. Investigations on the Silurian System of the St-Petersburg, Estonian and North-Livonian provinces including the Island of Oesel. *Archiv für die Naturkunde Liv-, Ehst- und Kurlands*, 1858, I. Série, **2** (in German).
5. Schmidt, F. On the Silurian (and Cambrian) Strata of the Baltic Provinces of Russia, as compared with those of Scandinavia and the British Isles. *Quarterly Journal of the Geological Society of London*, 1882, **38**(152), 414–436.
6. Schmidt, F. On the most recent views of the Silurian System of the St-Petersburg, Estonian and North-Livonian provinces including Ösel Island. *Trudy S.-Peterburgskogo obshchestva estestvoispytatelej*, 1879, **10**, 42–48 (in Russian).
7. Schmidt, F. Geological survey of the Silurian territory of the eastern Baltic and the revision of East-Baltic Silurian trilobite species. Part I. *Phacopiden, Cheiruriden, Encrinuriden. Mémoires de l'Académie Impériale des Sciences de St.-Petersbourg*, 1881, VII. Serie, **30**(1) (in German).
8. Zaleskij, M. The age of the marine sapropelic originating from algae in the Silurian period. *Izvestiya Peterburgskoj Akademii nauk*, 1917, Série VI, **1**, 3–26 (in Russian).
9. Schamarin, A. *Chemical Studies of Oil Shale of Kuckers*. Laakmann, Dorpat, 1870 (in German).
10. Fokin, L. On the structure and distillation products of bituminous burning rocks of the Province of Estonia. *Gornyj Zhurnal*, 1913, **2**(5), 117–142 (in Russian).
11. Tammiksaar, E. The beginning of oil shale industry in Estonia – prerequisites and causes: Historical insight. *Akadeemia*, 2013, **25**(1, 2), 15–49, 278–309 (in Estonian).
12. Anonymous. Overview of the activities of the Extraordinary Committee for Fuels. *Materialy po obzoru deyatel'nosti osobogo Soveshchaniya po toplivu za pervyj god ego sushchestvovaniya*, 1917, **1**, 104–109 (in Russian).
13. Anonymous. Summary of the protocol of the Petrograd Main Committee for Fuels, 08 May 1916. *Russian Historical Archives*, 58-2-702, sh. 4–4v (in Russian).
14. Shakhovskoj, V. Report about the Estonian oil shale and possibilities of its usage to the Emperor of Russia, Petrograd, 03 January 1917. *Russian Historical Archives*, 58-2-702, sh. 96v (in Russian).
15. Anonymous. Oil shale mining in the governments of Estonia and Petrograd. *Narodnoe khozyajstvo*, 1917, **1**(6–7), 15–20 (in Russian).
16. Pogrebov, N. Kukersite (Oil shale). In: *Khimiko-tehnicheskij spravochnik. Iskopaemoe syr'e*. (A. Fersman, E. Ereminova, eds.). Petrogr. Komitet Voennotekhn. Pomoshchi, Petrograd, 1918, **1**(1), 73–74 (in Russian).
17. Anonymous. Protocol of the meeting of the Extraordinary Committee for Fuels, the mining department, the Military Committee and the Geological Committee, after 02 November 1917. *Russian Historical Archives*, 58-2-702. sh. 291–293 (in Russian).
18. Yatsevich, M. Oil shale extracting in Scotland. *Izvestiya Osobogo Soveshchaniya po toplivu*, 1917, **3**, 84–85 (in Russian).
19. Winkler, H. v. *Estonian Geology*. Pihlakas, Tallinn 1922 (in Estonian).

20. Winkler, H. von (ed.). *Estonian Oil Shale: Research, Mining and Exploitation*. Wassermann, Reval, 1930 (in German).
21. [Raud, M.] *The [Estonian] State Oil Shale Industry 1918–1928*. Riigi Põlevkivitööstuse Kirjastus, Tallinn, 1928 (in Estonian).
22. Raud, M. Letter to A. Piip, Tallinn, 18 November 1918. *Estonian State Archive*, 20-1-9, sh. 6 (in Estonian).

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