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## HISTORICAL REVIEW OF THE KUKERSITE OIL SHALE EXPLORATION IN ESTONIA

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*In this paper a short review about the history of oil shale exploration in Estonia is presented, beginning from the 18th century, from the first notes written by A. W. Hupel, up to the present day. The numbers characterizing oil shale production within these years are presented, as well as the sizes of active and passive reserves of kukersite oil shale.*

### Introduction

In 1996, Estonian oil shale industry celebrated its 80th anniversary, but the history of oil shale exploration is twice longer.

The western part of the Baltic oil shale basin extends to Estonia's territory where it is divided, considering geographical and geological conditions, into the Estonia and Tapa\* deposits. Kukersite beds in the Estonia deposit belong to the Kiviõli Member (Viivikonna Formation, Kukruse Regional Stage), while in the southern Tapa deposit they belong to stratigraphically younger Peetri Member of the same formation (Fig. 1).

In the history of applied kukersite research four periods can be distinguished:

1. Up to 1916 - miscellaneous explorations characterised kukersite as a mineral of limited possibilities of utilization
2. 1916-1945 - single minor explorations carried out for obtaining mining permits
3. 1946-1993 - regular explorations financed from the state budget
4. Since 1994 - explorations financed by customers

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\* From the point of view of mining economy, Tapa is not a deposit, only an occurrence (*edit.*).

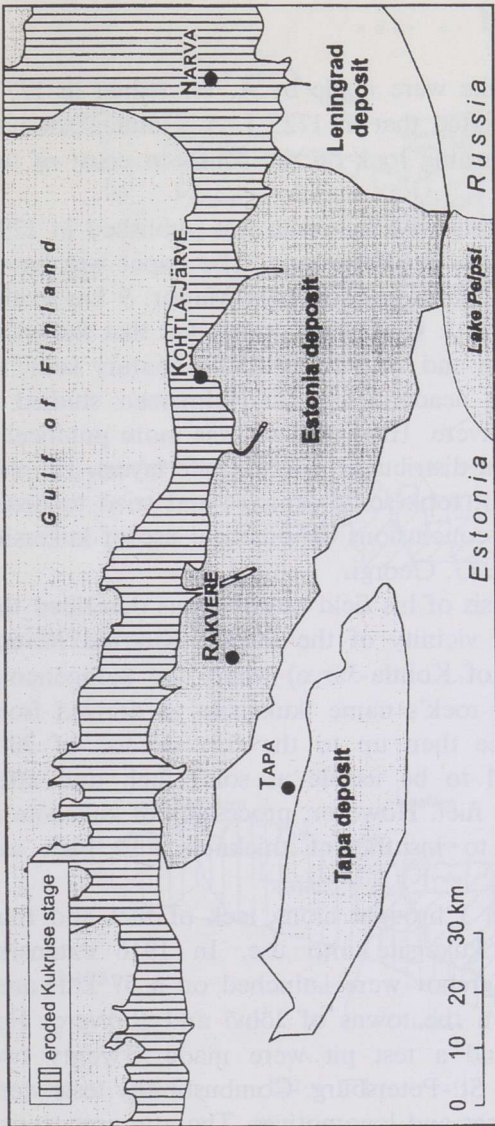


Fig. 1. Location and stratigraphical position of kukersite deposit

Middle Ordovician				division
Uhaku	Kukruse			Idavere stage
Kõrgekald	Viivikonna			Tatruse formation
Erra	Kiviõli	Maidla	Peetri	member
				cross-section

Estonia and Leningrad deposit

Tapa deposit



## Up to the End of World War I

First written notes about kukersite were made by A. W. Hupel in 1777. Ten years later P. S. Pallas reported that in 1725 I. A. Gldenstdt had mentioned the occurrence of burning rock on the southern coast of the Gulf of Finland.

The first scientific paper dealing with kukersite was published in 1791 by academician J. G. Georgi from St.-Petersburg. The paper was based on the samples collected on the territory of Kohala Manor, 9 km to the northeast of the town of Rakvere. J. G. Georgi concluded that kukersite could be used for producing heat and tar. Almost half a century later, in 1838, another St.-Petersburgian academician G. Helmersen studied a 1 km<sup>2</sup> area near the town of Rakvere. His approach was more practical - to identify horizontal and vertical distribution of kukersite layers. He also established a small open-cast pit, took some samples and tried to distill oil from kukersite. Helmersen's conclusions on practical use of kukersite coincided with those drawn by J. G. Georgi.

Fr. Schmidt [1, 2] on the basis of his field observations described the Kukruse Regional Stage in the vicinity of the former Kukruse Manor (5 km to the east of the town of Kohtla-Jrve) where the kerogeneous layers are at their thickest. The rock's name 'kukersite' is derived from the name of this locality. Since then up to the first decade of 20th century kukersite was supposed to be usable as solid fuel, and after processing - as liquid or gaseous fuel. However, processing of kukersite is economically inexpedient due to insufficient thickness and high ash content of its bed.

The beginning of World War I brought along lack of fuel and thus raised the question of taking kukersite into use. In 1916 extensive exploration works led by N. Pogrebov were launched on a 57 km<sup>2</sup> area along the railway tracks between the towns of Jhvi and Rakvere. For investigation shafts, trenches and a test pit were made. Twenty two wagons of oil shale were sent to St.-Petersburg. Combustibility tests were carried out at plants, boiler houses and locomotives. The attempts to use oil shale as fuel were made at the Kunda Cement Plant.

In the result of investigations carried out in 1916 [3], an oil shale industry development programme was compiled. Some ideas presented in it are valid even today:

- Kukersite could be used as fuel in households, steam boilers, locomotives, for cement combustion in rotary furnaces and producing lighting gas
- Kukersite is easily extractable in large amounts; however, it would be more effective to use kukersite for combustion in power plants or distilling different oils
- Kukersite ash can be used for making cement and bricks

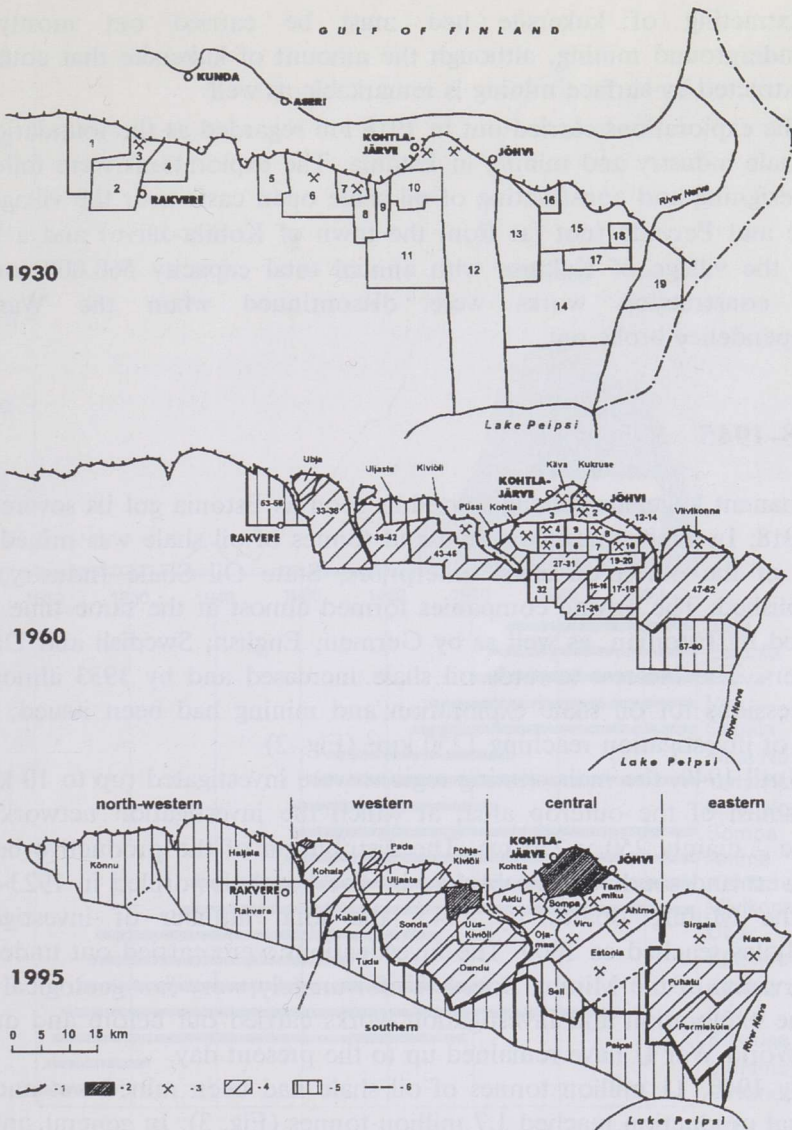


Fig. 2. Subdivision of Estonia deposit at different years: 1 - erosional line of the Kukruse stage; 2 - closed mines; 3 - active mines and open casts; 4 - fields covered with detailed exploration; 5 - fields covered with general exploration; 6 - boundary of conditional subdivision of the deposit



- Extracting of kukersite bed must be carried out mostly by underground mining, although the amount of kukersite that could be extracted by surface mining is remarkable as well

The explorations carried out in 1916 are regarded as the foundation of oil shale industry and mining in Estonia. The explorations were followed by designing and constructing of oil shale open casts near the villages of Järve and Pervade (not far from the town of Kohtla-Järve) and a mine near the village of Kukruse with annual total capacity 560,000 tonnes. The construction works were discontinued when the War of Independence broke out.

## 1918-1945

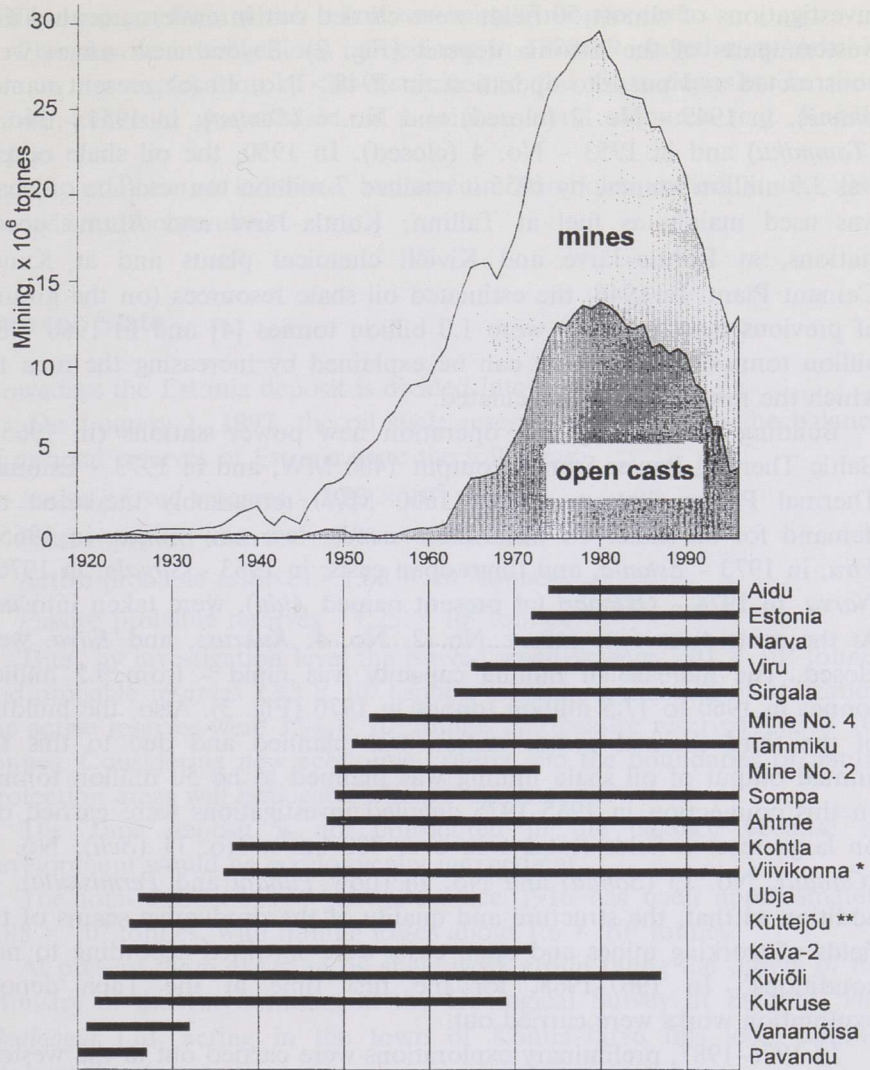
Permanent kukersite mining started as soon as Estonia got its sovereignty in 1918. In 1918, seventeen thousand tonnes of oil shale was mined out. One of the oldest oil shale enterprises, State Oil Shale Industry, was established. The private companies formed almost at the same time were owned by Estonian, as well as by German, English, Swedish and Danish owners. The interest towards oil shale increased and by 1933 almost 20 concessions for oil shale exploration and mining had been issued, total area of investigation reaching 1250 km<sup>2</sup> (Fig. 2).

Until 1940, the main mining regions were investigated (up to 10 km to the south of the outcrop area, at which the investigation network was dense - mainly 250 × 250 m). The distribution of the productive bed to the west and south was established by five boreholes drilled in 1923-1925 by the Mining Board. By 1945, the total number of investigation boreholes reached ca 1000. The investigations were carried out under the supervision of the Mining Board. Unfortunately, very few geological data of the exploration and investigation works carried out before and during the World War II have remained up to the present day.

By 1940, 11 million tonnes of oil shale had been mined out and the annual production reached 1.7 million tonnes (Fig. 3). In general, mining was started in open casts near the outcrop line of oil shale bed. Later, when the thickness of overburden rocks exceeded 8 m, oil shale winning was continued by underground mining.

## After World War II

Geological investigations of oil shale were intensified directly after the end of the war to restore the economy. In 1945-1946, detailed investigations were carried out on 14 small investigation fields in the central part of the deposit. Some fields were characterised by boreholes



\* - The Viivikonna open cast was incorporated with the Sirgala open cast  
 \*\* - The Küttejõu open cast was incorporated with the Kiviõli mine

Fig. 3. Kukersite production since beginning. Horizontal bars indicate years of activity of mines and open casts



made before or during the war. In 1947-1965, preliminary and detailed investigations of almost 50 fields were carried out in eastern, central and western parts of the Estonia deposit (Fig. 2). Several new mines were constructed and put into operation: in 1948 - No. 10 (at present named *Ahtme*), in 1949 - No. 2 (closed) and No. 6 (*Sompa*), in 1951 - No. 8 (*Tammiku*) and in 1953 - No. 4 (closed). In 1950, the oil shale output was 3.5 million tonnes, by 1955 it reached 7 million tonnes. The oil shale was used mainly as fuel at Tallinn, Kohtla-Järve and Ahtme power stations, at Kohtla-Järve and Kiviõli chemical plants and at Kunda Cement Plant. In 1946, the estimated oil shale resources (on the ground of previous investigations) were 1.0 billion tonnes [4] and in 1960 - 3.3 billion tonnes. The increase can be explained by increasing the area for which the resources were calculated.

Building and putting into operation new power stations (in 1965 - Baltic Thermal Power Station, output 1400 MW, and in 1973 - Estonian Thermal Power Station, output 1600 MW) remarkably increased the demand for oil shale. To meet these needs, two new mines: in 1965 - *Viru*, in 1973 - *Estonia*, and three open casts: in 1963 - *Sirgala*, in 1970 - *Narva*, in 1974 - *Oktoobri* (at present named *Aidu*), were taken into use. At the same time four mines: No. 2, No. 4, *Kukruse*, and *Käva*, were closed. The increase of mining capacity was rapid - from 9.2 million tonnes in 1960 to 17.5 million tonnes in 1970 (Fig. 3). Also, the building of the third thermal power station was planned and due to this the annual output of oil shale mining was planned to be 50 million tonnes. In this connection in 1965-1975 detailed investigations were carried out on large reserve fields (total area over 700 km<sup>2</sup>): No. 11 (*Seli*), No. 12 (*Oandu*), No. 13 (*Sonda*) and No. 14 (now *Puhatu* and *Permisküla*). In addition to that, the structure and quality of the productive seams of the fields of working mines and open casts were specified according to new conditions\*. In 1967-1968, for the first time at the Tapa deposit exploration works were carried out.

In 1976-1987, preliminary explorations were carried out in the western and northwestern parts of the Estonia deposit. The prospecting of the Tapa deposit took place in 1982. In the second half of the 1970s, systematical post-exploration works of the mining fields were started, at which the attention was paid to identifying karst belts and tectonical jointing.

In 1981, in the Leningrad District Sosnovõi Bor, Nuclear Power Station was put into operation, in the result of which in the north-western part of the former USSR the need for electric energy produced from oil shale noticeably decreased. This process led to the decrease of oil shale production in Estonia: in 1980 - 29.7 million tonnes, in 1985 -

\* Low conditions (*edit.*).

25.7 million tonnes, in 1990 - 21.2 million tonnes and in 1995 - 12.1 million tonnes, from which a half was mined in open casts.

Phosphorite investigations carried out in 1978-89 played a remarkable role in the exploration of the Estonia and the Tapa deposits. In their course kukersite was studied as a joint mineral resource (e.g. Kabala field).

The number of kukersite exploration boreholes drilled since 1945 exceeds ten thousand.

## Current State

Nowadays the Estonia deposit is divided into 26 fields (Fig. 2).

On January 1, 1997, the oil shale reserves accounted in the balance of mineral reserves of Estonia were the following:

- Active proved reserves -  $2.23 \times 10^9$  tonnes
- Passive proved reserves -  $0.78 \times 10^9$  tonnes
- Active probable reserves -  $1.68 \times 10^9$  tonnes
- Passive probable reserves -  $1.25 \times 10^9$  tonnes

Thus, by investigation level the proved reserves were  $3.01 \times 10^9$  tonnes and probable reserves  $2.93 \times 10^9$  tonnes, while by possibility of utilization the active reserves were  $3.91 \times 10^9$  tonnes and passive reserves  $2.03 \times 10^9$  tonnes. Considering new economic criteria and the boundaries of nature protection areas will noticeably change the reserves.

The Tapa deposit is not considered in the balance because its development would be economically inexpedient.

The total extraction of kukersite since 1916 has been approximately  $0.85 \times 10^9$  tonnes, with mining losses about  $1.6 \times 10^9$  tonnes.

At present there exists an oil shale work group filling the orders of the Ministry of the Environment at the Geological Survey of Estonia. *Viru Geologia* Ltd. acting in the town of Kohtla-Järve fills local applied geological orders.

Today the main results of oil shale prospecting are as follows:

- The Estonia deposit has been geologically lined out, the Tapa deposit is in the prospecting stage
- The bedding conditions of oil shale bed as well as general changes in its structure and quality have been established for the Estonia deposit
- Large probable reserves have been established

For some fields (e.g. northern fields of the western part of the deposit) additional investigations must be carried out in order to specify the quality and hydrogeological conditions.



## REFERENCES

1. *Schmidt Fr.* Die silurische Formation von Ehstland, Nord-Livland und Oesel. Archiv für die Naturkunde Liv-, Ehst- und Kurlands. I S., Bd. II. Dorpat, 1858.
2. *Schmidt Fr.* Revision der ostbaltischen silurischen Trilobiten nebst geognostischer Übersicht des ostbaltischen Silurgebiets. Abt. I Phacopiden, Cheiruriden und Encrinuriden. Mém. de l'Acad. Imp. des Sciences de St.-Pétersbourg, VIIe Sér., t. XXV, n° 1. St.-Pétersbourg, 1881.
3. *Pogrebov N. F.* Baltic oil shales // Natural Productive Forces of Russia. Russ. Ac. Sci. Petrograd, 1919 [in Russian].
4. *Luha, A.* Mineral Resources of the Estonian SSR. - Tallinn, 1946 [in Estonian].

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