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GENETIC TYPES OF OIL SHALES IN HUNGARY

by

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As a result of the research work during the reambulation of geological mapping started in 1973, four occurrences of oil shale deposits were discovered in Hungary (Fig. 1). Except for two indications, the oil shale deposits were formed during the Late Neogene. Regarding the environments of sedimentation, two main types can be distinguished:

1 oil shales deposited in maars,
2 oil shales deposited in intramontane lagoons.

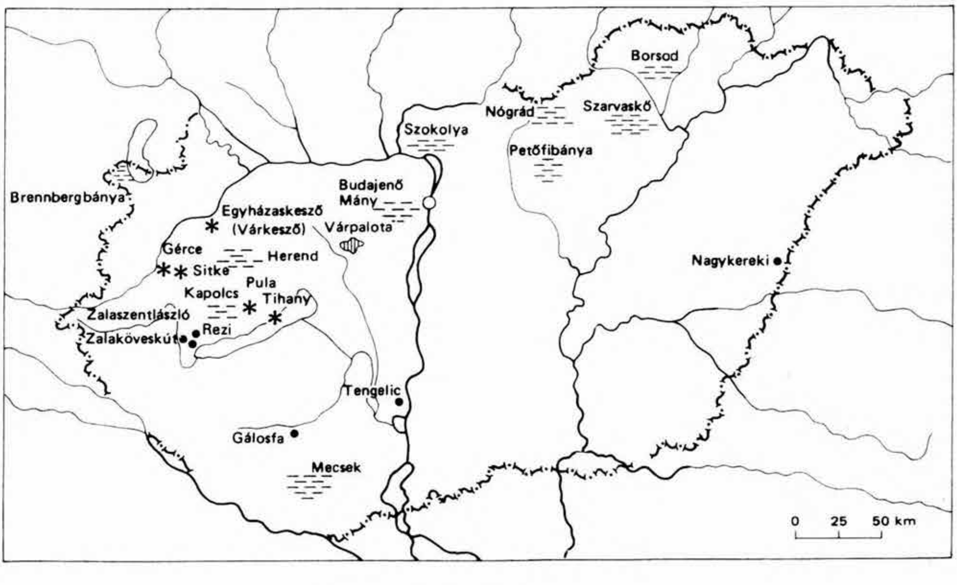


Fig. 1. Oil shale occurrences in Hungary (after G. Solti, 1984)
1 Maar volcano, *2* lagoon type oil shale indication, *3* oil shale deposit, *4* oil shale indication in borehole

In further detail an attempt has been made at showing the major characteristics, of the two different genetic types of oil shales (Fig. 2, 3), in order to facilitate the discovery of similar deposits beyond the borders of Hungary.

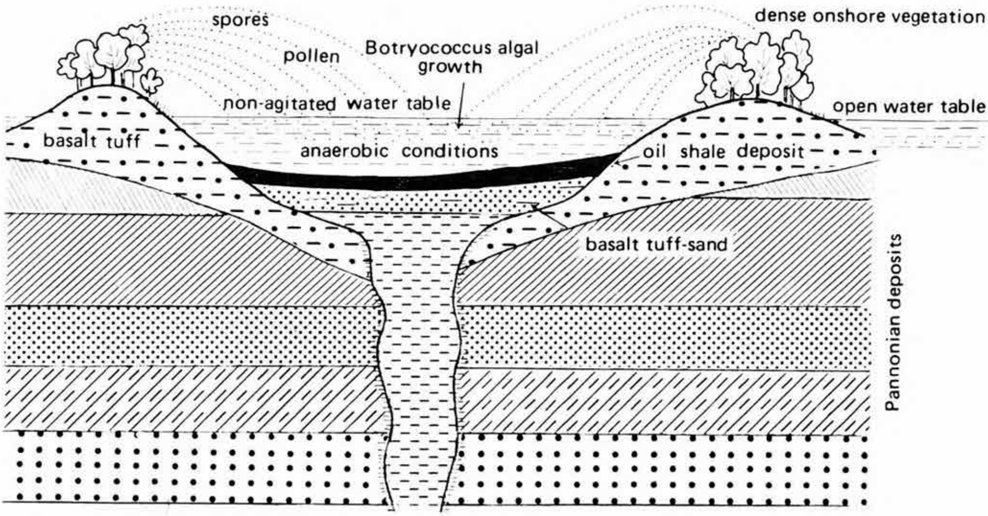


Fig. 2. Oil shale formation in a volcanic crater (after G. Solti, 1984)

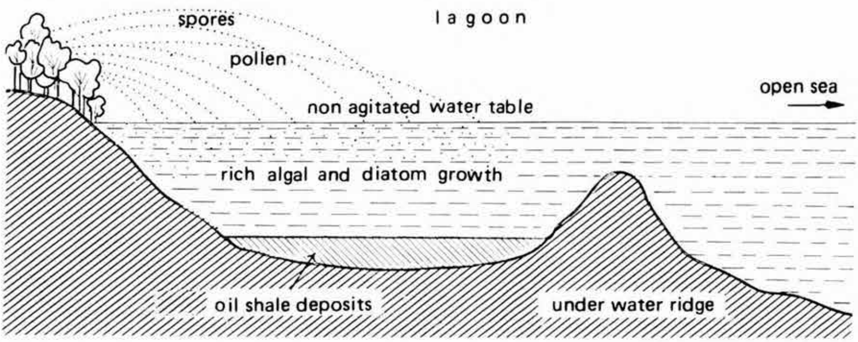


Fig. 3. Oil shale formation in a lagoon (after G. Solti, 1984)

Maar-type deposits

In the Little Plain and the Balaton Highland, the process of sedimentation in a series of small basins characterized by shallow, brackish water during the Late Pannonian was interrupted by a volcanic activity of alkali basalt type. As a result of repeated eruptions, circular accumulations of pyroclastic material were built up, like rings, around the volcanic craters. Where the top of these tuff rings emerged above the sea level, a small, closed sedimentary basin with special characteristic features could develop. In the region of the extended lake system that time, this type of crater lakes was also represented.

Represented by deciduous forest, as proved by remnants of Ulmus, Carpinus, Fagus, Quercus and also the undergrowth, the vegetation worked against large-scale erosional processes and against the transportation of coarse detritus into the lake.

The water of these crater lakes was oligohaline type as a result of rainfall and periodical brackish water inflow with a salinity of 3% a pH of 7.6 and an average temperature of 20 °C. Because of the slow erosion of the basaltic tuff along the slopes and the rapid weathering of the hydrated, basic pyroclastic material and the contemporaneous streams of postvolcanic activity, the water of the lake got enriched in silica and essential rare elements.

This environment was favoured by particular organisms, algae and diatoms, respectively. Among others, the *Botryococcus braunii*, an oil-generating algal species, occurred in unusual abundance. During the warm season a biomass was formed by the flourishing algal culture in the lake. Anorganic components, siliceous, calcareous and argillaceous material played a major role in sedimentation, while organic matter was deposited in greater amount during the cold season. Laminae 0.1 to 5 mm thick and alternately rich and poor in organic matter resulted in a varved sedimentary sequence of annual rhytmicity. During lithification, laminae rich in organic matter were altered into alginite, calcareous alginite or diatomaceous alginite by the process of diagenesis. A series of rock types of different composition was defined by petrographic examinations but, here and now, we confine the petrographic definition of the alginite is understood in a more strict sense. The rock type called alginite consists of figured algal remains and fragments of algal colonies, both being infiltrated and cemented by opal enclosing also tests of diatoms and containing bituminites. It forms thin layers, patches and dispersed drops of microscopic size. Megascopically, it can be characterized by a brownish-green, grayish-green colour, laminated structure. Its bulk density is approximately 0.9, the bituminite content being over 10%. When lit by striking a match, the rock can be easily burnt.

Following the uplift of the area the crater lake ran dry and under favourable circumstances it was buried by Pleistocene, Holocene sedimentary rocks and thus prevented from erosional processes.

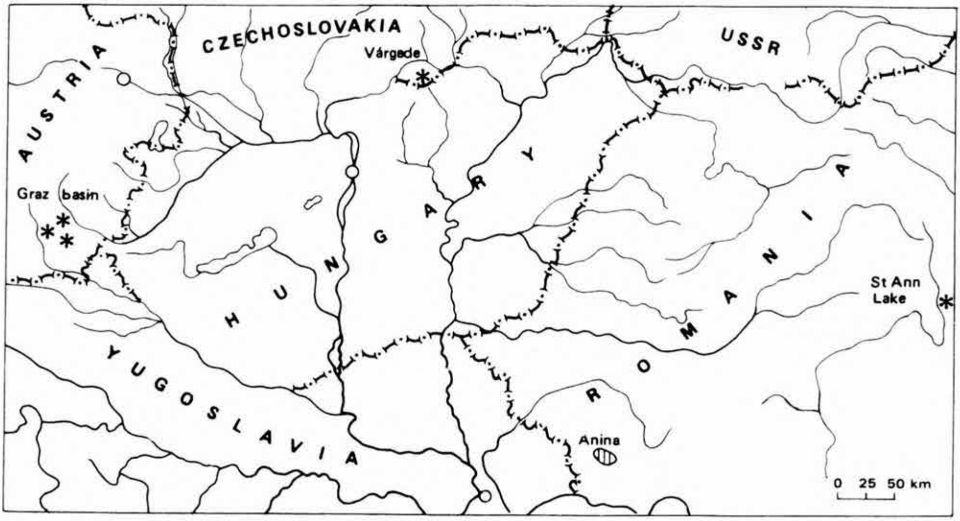
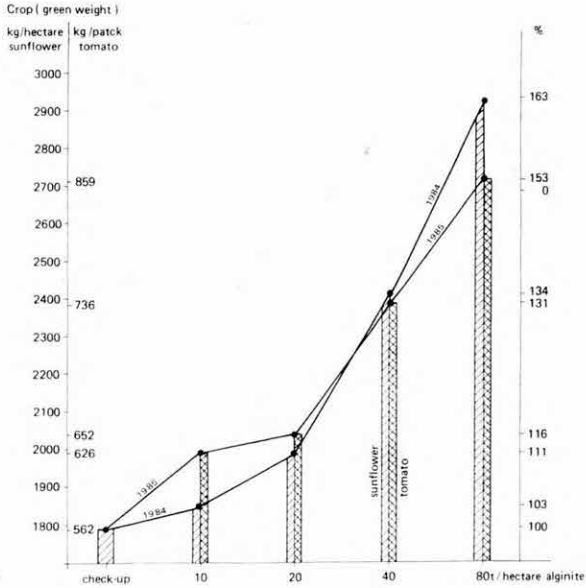


Fig. 4. Alginit accumulation can be supposed in Graz basin, Slovakia and Transylvania



	pH (KCl)	Arany-type bond	$CaCO_3$	Humus	P_2O_5	K_2O	N	Mg	Mn	Na	Zn	Cu
					Soluble in ammonium lactate total							
			%	%	ppm							
Alginite	7,68	>90	14,5	14,3	410	1020	1086	295	102	62	4,6	>10
Sandy soil	7,33	24	17	0,97	187	164		55	75,3	51	22	10,9

Fig. 5. Increase of sunflower and tomato yield due to the influence of amelioration with alginite at Izsák

Seven crater lakes of this type covered by younger sediments were investigated in detail. Three of these have a lacustrine sedimentary sequence with alginite deposits. The thickness of these sedimentary rocks varies from 40 to 90 m, the diameter of the tuff rings is between 330 and 2000 m. The total volume of the accumulated raw material is 130 million tons.

Alginite and oil shale deposits in crater lakes bordered by tuff rings were first recognized in Hungary. This characteristic sequence, now called the Pula Alginite Formation after the type locality at Pula, is explored by boreholes.

In terms of palaeogeography and geological environments, the Early Pliocene Carpathian basin during is supposed to have offered favourable conditions for alginite accumulation. And this holds true for territories outside Hungary as well (Graz basin, Slovakia, Transylvania). Some of these further occurrences could be detected along the fault line of the river Rába as a continuation of the alginite deposits of the Kemeneshát, up to the Alpine range, where a few rings of maar-type basaltic volcanoes, probably filled with alginite deposits, are found.

Lagoon-type deposits

Detailed information about the deposition of alginite in crater lakes induced geologists to detect similar material in sedimentary basins of similar environment.

Sedimentary basins, closed periodically by bars, with nonagitated brackish waters of shallow depth, filled by tuffaceous, diatomaceous, pelitic layers of claymarl and marl and containing also organic material, were taken under searchlight. Such facies represented by intramontane basins and lagoons of the Neogene sea are well known within the country. This kind of environment seems to be similar to places of evaporite deposition. Using the bar theory, a similar model can be adopted. The basin, a bay or lagoon, is partly closed against the open sea. In the relatively warm brackish water, vegetation-generating hydrocarbons could start flourishing. Accumulations of organic material were supplied simultaneously by large amount of spores and pollen grains of a lush vegetation along the coast. The remains of flora, rich in hdyrocarbons deposited on the basin floor in an anaerobic environment. In case of swampy shores no coarse-grained anorganic detritus was transported into the basin.

The oil shale deposited in this type of basins is megascopically similar to the alginite of maars. The rock is greenish-brownish gray in colour, thin lamellae rich in organic component alternate with lamellae or thin layers of silty clay-marls, marls, diatomaceous, tuffaceous layers commonly occur, too. Due to the reducing, anaerobic conditions the benthonic fauna is completely missing.

The shale oil content of the layers rich in organic material varies between 5 and 55% mainly as a derivative of spores and pollen grains.

Significant deposition of lagoon-type oil shale can be found in the Várpalota basin in Transdanubia, at the foot of the Bakony Mountains. Covering an area of approximately 50 km^2 it was deposited during the Badenian and is overlain by regressional lignite layers.

With a view to using the oil shales, i.e. alginite, for practical purposes, numerous inventions were developed as documented by sixteen patents and licences, by the Hungarian scientists. Most significant of these is, as the authors believe, the utilization of natural alginite and oil shale in agriculture for soil melioration. Alginite, as a natural fertilizer, can stimulate plant growth considerably and this kind of fertilizer is valuable from the point of view of environment protection, too.

As proved by agricultural experiments run continuously since 1977, the alginite deposited in crater lakes is quite promising for agricultural utilization, being considered a fossil biomass. The intense growth of Algae, among others, can be attributed to the weathered volcanic material, the microelement content, incorporated in the organism of Algae. It is assumed that, as a result of a reverse process, the slightly diagenized alginite, when fed into the soils, may act again as a nourishing and microelement-supplying agent. This material contains humus needed for crop production, together with the necessary nutritive macro- and microelements in a form that can be directly taken up by the plants. The 10—15% humus contained in the alginite exceeds several times the humus content of the best chernozem. The high clay content (60—80%) enables the fixation of loose sandy soils and the improvement of their composition. Simultaneously, the water storage capacity of the soil increases, the water regime improves and a more balanced absorption of water by the plants becomes possible for a longer period.

As a result of the alginite's organic matter supply, nutritive capacity, composition improvement and water-regime control of the ameliorated soils depending on the dosage and on the soil type (1—5 kg/m^2), the crop yields can be increased by 15—50%. As an example an experiment will be described that was carried out on sandy soil, short of humus. In 1984 on soils ameliorated with alginite from Gérce, sunflower was grown, while in 1985 on soils ameliorated with alginite from Pula (Vázsony), tomato was grown. On experimental plots of 100 m^2, and 500 m^2, respectively, by applying doses of 10, 20, 40 and 80 t/ha (kg/m^2) the yield in case of sunflower was 3—63% higher, while in case of tomato it increased by 11—53% as compared to the untreated control plots (Fig. 5).

The ameliorating effect lasts for 4—6 years. The alginite is practically applicable to all soil types and any crop.

A lime content of about 30% makes possible the neutralization of soils that got acidized as a result of the excessive use of fertilizers.

Perhaps the environment-protecting impact of the alginite is even more important than the amelioration and regeneration of the soils got exhausted due to forced increase of crop yields. Once fed to the soil, the clay minerals of the alginite (illite, smectite) bind the fertilizers, which then, enhanced by rainwater, will gradually and evenly get to the roots of the plants. By this the removal of potassium and phosphorus is reduced, the live water is less polluted, and the nitrate content of the subsurface waters (drinking water) is diminished. Also, on account of the clay mineral content, the alginite's absorptive ability to prevent the disintegration of organic matter will improve the microclimate of animal-breeding sites and stables, the odour control and the blotting-up and compaction due to liquid manure.

For the utilization of the oil shales and alginites in their natural state not only the Hungarian alginites of the volcanic crater lakes are suitable. This statement is proved by pedological experiments carried out by using Yugoslavian and Maroccan oil shales in plant-growing plots.

At present, alginite is extracted and sold from two pits in Hungary and the material is used for agricultural purposes, such as amelioration, preparation of various soil mixtures, and for solving problems of environment protection. Its application is first of all preferred in minor cash-producing gardens, where the crop- and flower production is performed without using chemicals or fertilizers.

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