COMMERCIAL ZONATION OF THE ESTONIA OIL SHALE DEPOSIT

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ABSTRACT

For the commercial zonation of the Estonia oil shale deposit, its area was divided into 4*4 km squares. For each square, the means for a set of parameters characterizing the commercial horizon and oil shale quality in the corresponding block were calculated. Statistical analysis revealed regular and strongly correlated changes of the parameters characterizing the thickness and caloric value of the kukersite seams: they have the highest values in the central part of the deposit, decreasing towards the marginal parts. The commercial zonation based on these regularities subdivides the Estonia deposit into three economic regions: (I) central commercial, exploited at present, with the remaining resources for 40-50 years (at the production rate of 25-30 million tonns per year); (II) subeconomic part adjacent to central region (40-50 years) and (III) submarginal part.

The total production of the Estonia deposit since the beginning of the oil shale (kukersite) production is above 650 million tonns of shale product. The total exhausted area covers about 300 km^2. Mining and usage of kukersites is economically effective because of the high quality of the shale, good geological and mining conditions and relatively low production and transport costs.

The deposit contains about oO per cent of the balance resourcces and gives above 80 per cent of oil shale production of the USSR. With the building of nuclear power stations and the settlement of the half-peak regime in the shale power stations. the shale production decreaseo from 31 million to 25...26 million tonns per year.

The commercial horizon of the Estonia deposit

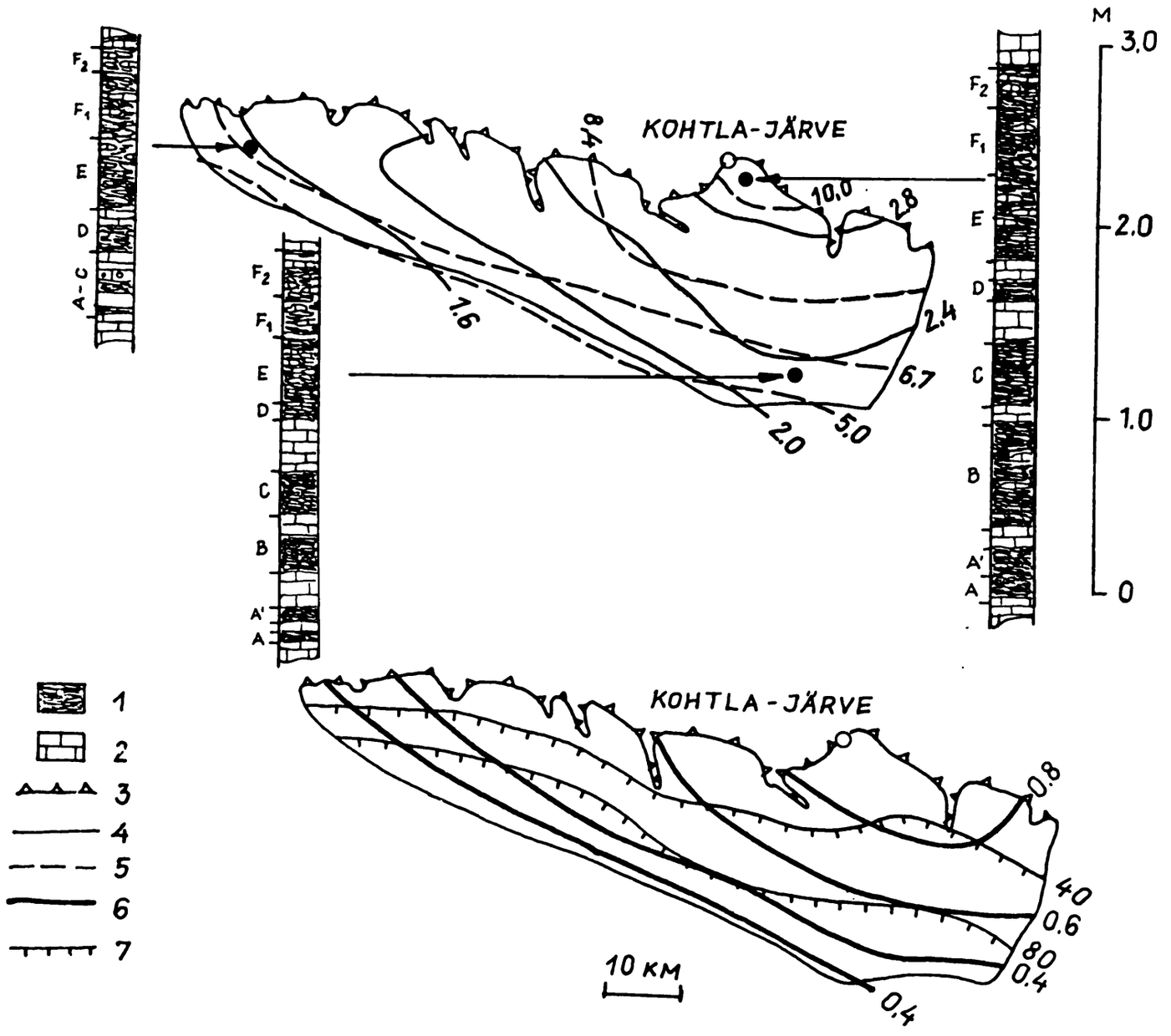

Figure 1. Changes of the main parameters of the commercial horizon A-F_1. 1-kukersite; 2-limestone; 3-erosion boundary; 4-isopachs of the sum of the kukersite seam thicknesses (H_t,M); 5-isopachs of the caloric value (Q_t,MJ/kg); 6-isopachs of the productivity (P,t/m^2); 7-depth,m.

includes the lower part of the Middle Ordovician Kukruse Stage: the kukersite seams A,A',B,C,D,E,F_1 and F_2 separated by limestone beds. The horizon deeps monoclinally with the angle 0.25 degrees to the South, where the thickness of the covering Middle and Upper Ordovician limestones reaches 120 m (Fig.1). For the commercial zonation of the Estonia oil shale deposit, its area was divided into 4*4 km squares /1/. For each square, the means for a set of parameters characterizing the commencial horizon and oil shale quality in the corresponding block were calculated. The total thickness of the commercial horizon A-F_2 (H_t,Fig.1) decreases from the centre (3.1 m, nearby Kohtla-Järve) to the marginal parts of the deposit, with the decrease in the sum of the kukersite seam thicknesses (H_{sh}) and rather stable thicknesses of limestone beds (Fig.2). The maximum thickness of the lower seams (A-C) is located near Kohtla-Järve, while that of the upper seams (D-F_2) locates in the West of this town /1,2/.

The composition and quality of oil shales can be estimated by means of three main compounds: organic matter (OM), carbonate (Car) and terrigenous (Ter) component contents. The ratios of these contents vary in different seams, but their lateral changes are analogous: Car increases to the West and Ter to the South and East from the centre of the deposit.

The OM content decreases from the centre towards the marginal parts of the deposit, in the direct correlation with the decrease of the horizon thickness (H_t), the mean caloric value (Q_t), the sum of the kukersite seam thicknesses (H_{sh}) and their mean caloric value (Q_{sh}; Fig.2). The same circumstances explain the correlation of Q_t, the enrichment product quality (Q_s^d) and the amounts of different oil shale products - the high quality shale for pyrolysis and the solid fuel for energetics (Fig.4.);/2/. Figure 5 displays the correlation of the caloric value of the shale (Q_s^d), and the relationships between the above quality parameters /4/.

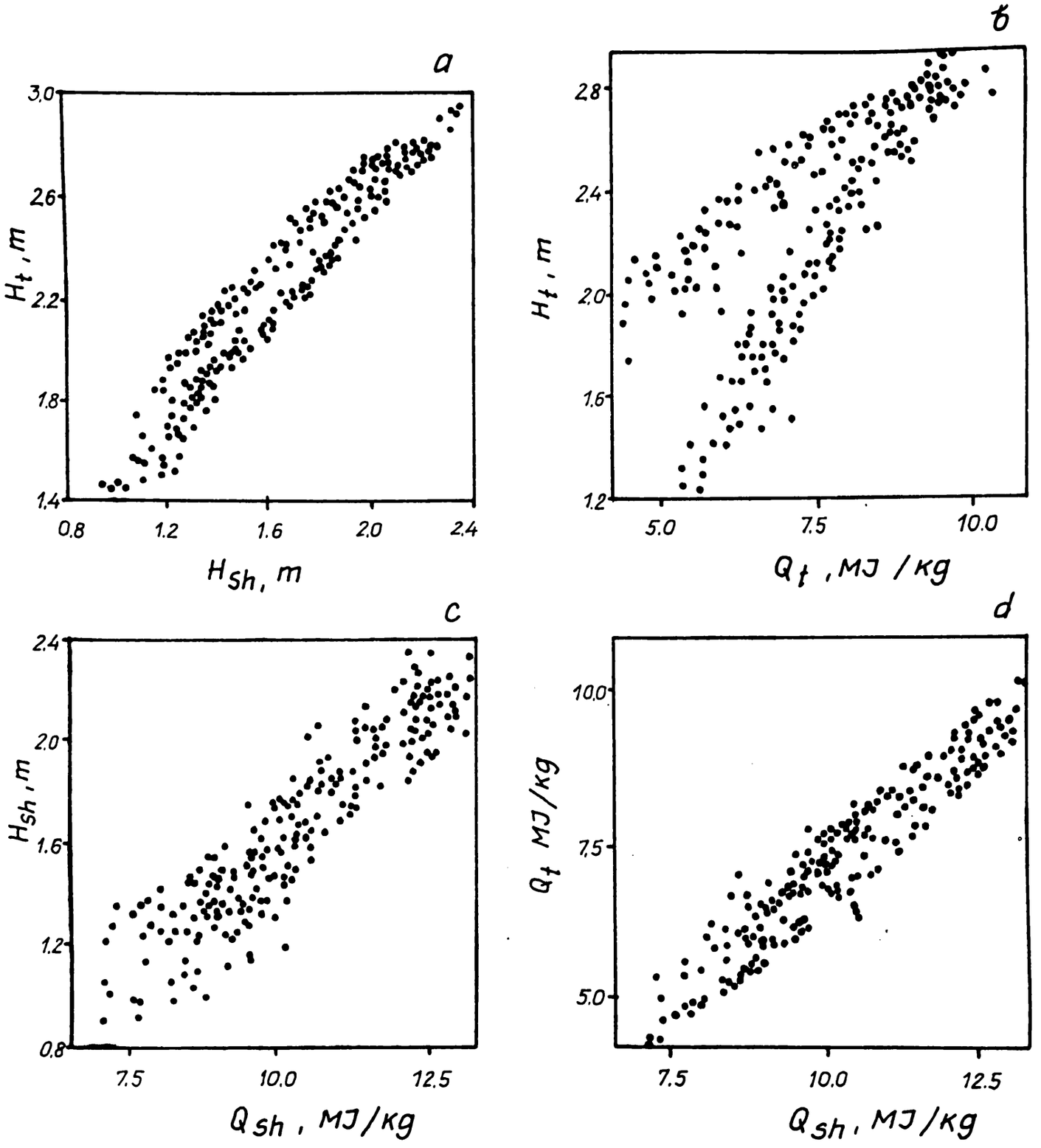

Figure 2. Pairwise plots of the main parameters of the commercial horizon: (a) H_t,H_{sh}; (b) H_t,Q_t; (c) H_{sh},Q_{sh}; (d) Q_t,Q_{sh}.

Stati tical analysis revealed regular and strongly correlated changes of the parameters (thickness, OM content, caloric value and oil yield of the kukersite seams) indicating the best mining conditions in the

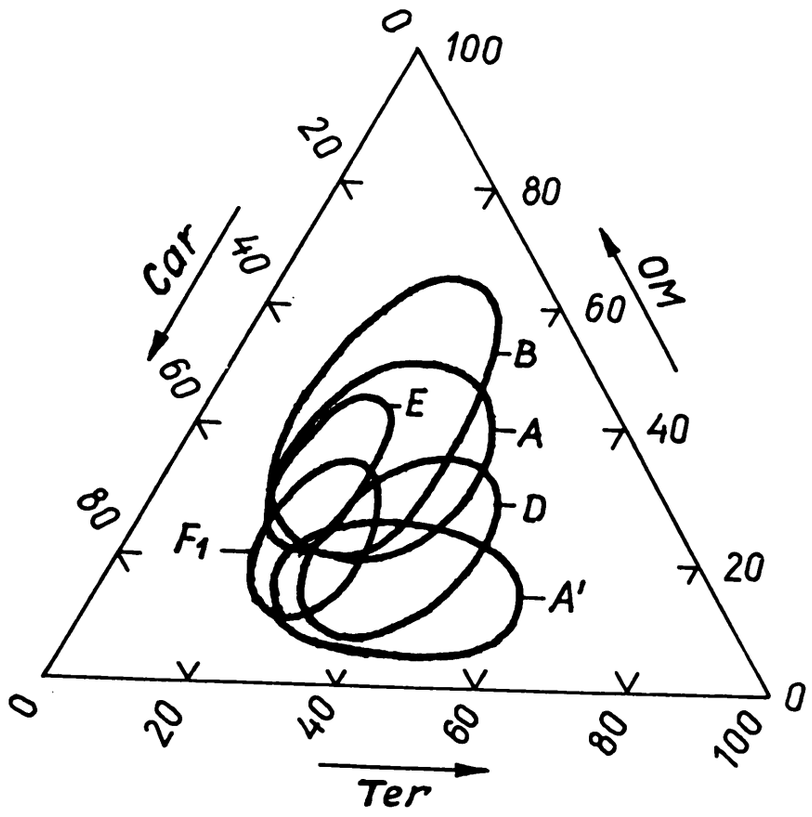

Figure 3.
The composition of the kukersite seams ($A-F_1$).

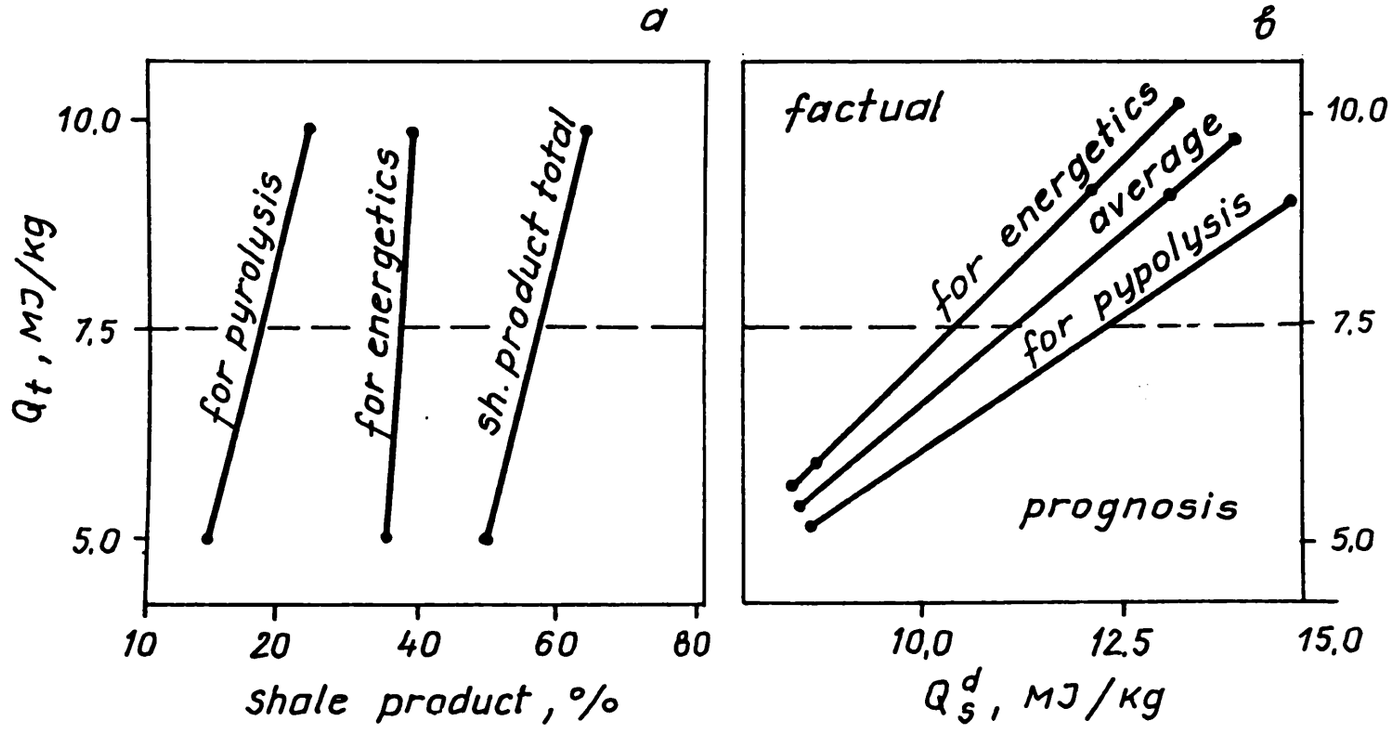

Figure 4. Correlation of the shale product per cent and caloric value (Q^d_s) of the commercial oil shale and that of the source rock (Q_t),/2/.

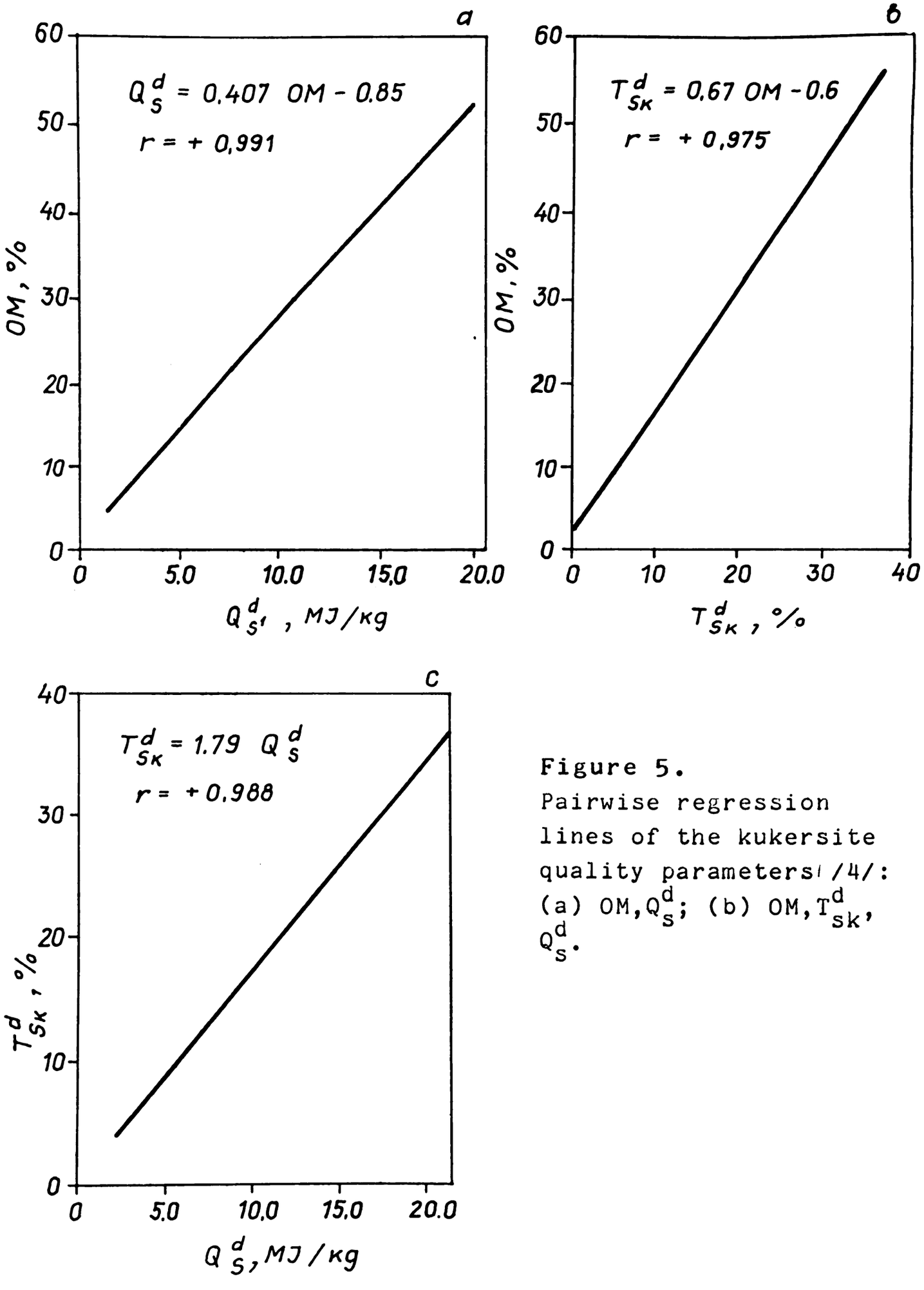

Figure 5.
Pairwise regression lines of the kukersite quality parameters /4/: (a) OM, Q^d_s; (b) OM, T^d_{sk}, Q^d_s.

central part of the deposit. Towards the marginal parts, the values of the quality parameters decrease and the production costs increase, with the increasing depth of the horizon /5/. The commercial zonation based on these regularities subdivides the Estonia deposit into three economic regions (Fig.6,Table).

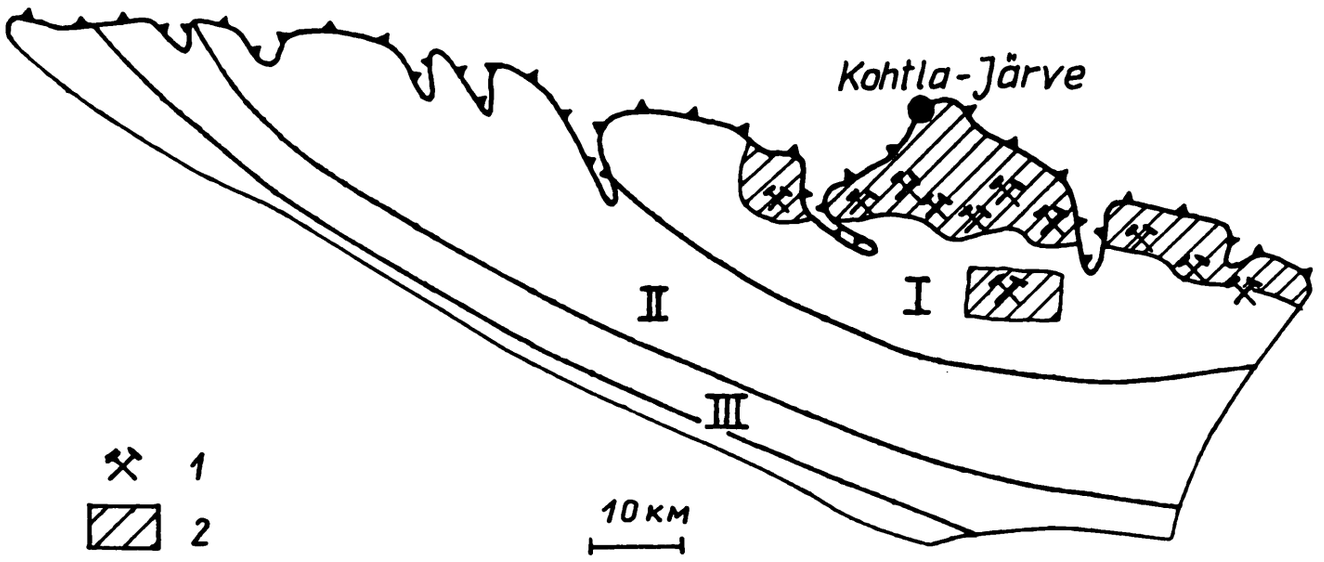

Figure 6. Commercial zonation of the deposit. Regions: I - commercial, II - subeconomic, III - submarginal. 1 - oil shale mines; 2 - mostly exhausted area.

Table. The main characteristics of the commercial oil shale horizon A-F_1 of the Estonia deposit.

ZONE	Exhausted	I	II	III
Area ,km^2	300	770	1,300	600
Depth,m	0-50	0-60	0-90	0-120
H_t ,m	2.8-3.0	2.2-2.9	1.6-2.4	1.4-2.2
Q_t^t ,MJ/kg	9.2-10.5	7.5-9.6	6.1-7.5	5.0-6.3
H_{sh},m	2.0-2.4	1.4-2.3	1.0-1.8	0.9-1.4
Q_{sh}^{sh},MJ/kg	11.7-13.4	10.5-13.0	8.4-11.3	7.1-9.6
T_{sk}^{d},%	20.9-24.0	18.7-23.2	15.0-19.5	12.7-16.5
P,t/m^2	0.7-0.95	0.55-0.87	0.35-0.67	0.24-0.38
Conventional costs	1	1-2	2-3	3-5
Life period,years	-	40-50	40-50	15-20

Central commercial region (I) is exploited at present and has the remaining resources for 40-50 years (at the production rate of 25-30 million tonns per year). The amount of the shale product for pyrolysis achieved by enrichment reaches 25 per cent of the source rock.

Subeconomic part (II), adjacent to the central region is located in the South and West from the latter. The enrichment product is suitable for the production of the solid fuel for energetics only. The production is not profitable unless the prices for the shale products will not rise significantly. The life period of this part at the given production rate will be 40-50 years.

Submarginal part (III) of the deposit is not of economic interest.

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