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A Study on the Morphology of the Quartz Grains in the Consistence of Loess

Исследование морфологии кварцевых зерен в лёссовых отложениях

Badania nad morfologią ziarn kwarcowych w utworach lessowych

The scarcity of studies on the morphology of loess grains shows how inadequate is our knowledge about the physical properties of loess sediments. Reports on the morphology of grains are found in many papers on loess but they are inadequate and very often the conclusions are not confirmed by concrete data. Compared with the ample materials on the granulometric or mineralogical composition of loess, the role of the character of grain shape is usually dealt with marginally. It is often assumed in advance that mineral grains below a certain size are not subject to mechanical transformation.

According to Syniewska (9) quartz grains below 0.14 mm are not rounded but always sharp-edged. If this is true, it may be assumed that the quartz grains which constitute the main constituent parts of loess were not mechanically transformed.

It is known that the characteristic fraction of loess consists of particles 0.005-0.1 mm in diameter. It is sometimes claimed that loess sediments consist of very fine sharp-edged quartz silt (15). Many research-workers also mention the rounded quartz grains to be found in loess, of a diameter smaller than the minimum defined by Syniewska (9). It is said that the quantity of sharp-edged quartz grains increases as the size of the fraction decreases, but no index is quoted to prove this statement. Cayeux (1) says that the average grain size for Chinese loess is 0.06 mm in diameter. He also claims that loess grains are sharp-edged,

or partly rounded. In his treatise on loess (10) Scheidig writes of the occurrence of the rounded quartz grains as a normal phenomenon. Moreover, the rounding is not connected with any definite size limit of quartz particles. This author believes that even grains with a diameter of 0.003 mm may be subject to the process of rounding.

A more detailed outline of the morphology of the quartz grain is given only in Tokarski's paper (13) on the loess on the Podolian Upland. According to Tokarski microscopic pictures of all loess samples are identical. Angular grains are most frequent although partly rounded grains also occur. However the relation between rounded and angular grains in separate samples varies to a considerable degree. The loess of the Podolian Upland thus shows no regularity with regard to either the amount or the size of the rounded quartz particles (10, 13).

Raczkowski (6) like Tokarski established the direction of the transport of loess dust on the basis of the sorting and the degree of grain rounding. Malinowski and Mojski (3), when making an examination of the loess profile in Sąsiadka (Roztocze), found a low degree of grain rounding. According to them rounded grains occur below sharp-edged grains and do not prevail in any horizon .They also state that larger grains are occasionally more rounded.

During an examination of the loess sediments within the area situated between the Kamienna and Krępianka rivers, Radłowska (7) has given the granulometric composition and the morphoscopy of the grains, together with their degree of rounding and dullness. She adapted Tokarski's method. Radłowska examines a number of samples from different horizons and different outcrops. She gives a description of each sample, including an account of the morphology of the quartz grains. However, this paper lacks detailed quantitative data, which would make possible an assessment of the relationship between particles characterized by different degrees of the rounding. The angularity of quartz particles, 0.1 mm in diameter, does not, according to Radłowska, provide „sufficient evidence", because grains of that size behave in water and eolic transports very much alike (14).

The data assembled above show that research on the morphology of loess quartz grains has so far failed to provide sufficient material concerning the main component of loess.

The purpose of this paper is to examine the problem of the occurrence of rounded mineral grains in loess. It was necessary to state their occurrence in different fractions and to establish the relation of these grains to those which are sharp-edged. Moreover, the author wished to find out whether the occurrence of rounded quartz grains in silt fractions can differentiate typical loess from the so-called pseudoloess.

For this purpose microscopic preparations were made from selected loess samples, as well as from silty materials resembling loess. In order to obtain pure quartz grains, calcite was removed from the samples by washing them with chlorhydric acid solution and with distilled water. This also helped to separate the quartz grains. A little silt material was introduced into a small amount of glycerine (chemically pure). After being mixed up delicately together, a suspension of silt in glycerine was obtained. In the course of mixing care ought to be taken not to cause a mechanical change in the quartz particles. From the samples prepared in that way a microscopic preparation was made. The cover glasses were kept perfectly clean. Microphotographs were taken, the magnification being 100-fold. Numerous experiments have shown that a successful morphological description of grains may be obtained by the analysis of 10 photographic pictures of various fragments of one preparation. The next stage was to magnify the picture obtained on microfilm to the scale 500×1. In order to establish exactly the magnification scale, before taking the photograph of the preparation, with the microscope in exactly the same position, a photograph of the micrometrical scale was taken. The analysis of the morphology of the grains was carried out on the basis of microphotographs of the preparations. Thanks to the scale of magnification the size, shape, degree of rounding and the morphology of the surface of quartz grains could be accurately established. It was also possible to distinguish other minerals among the quartz grains. The measurements of the size of the grains were made by means of a celluloid slice with circular holes cut out in it, the diameter of which corresponded to the size of the respective fractions.

When analysing the microphotographs of silty material in this way, minute fractions of grains below 0.02 mm in diameter were not considered. But the grains of the fraction 0.02 to 0.005 mm in diameter were subjected to immediate microscopic analysis by using the 1500-fold magnification (immersion objective $100 \times$ and eyeglass $15 \times$). Whenever there was difficulty to establish its shape the grain was set in rotative motion by pressing gently the top glass of the preparation. For this reason glycerine was used in making the preparations instead of Canadian balsam or some other coagulating medium. The measurements of the above-mentioned grains (fractions 0.02 to 0.005 mm) were taken by means of a microscopic eyeglass, which had its own scale.

Both microphotographs and direct microscopic observations were made in ordinary light, with a clear field of image. In order to obtain contrasting and expressive images a yellowish-green filter was used.

By means of measurements and calculations made on photographs and directly under the microscope, figures were obtained regarding the

degree of rounding as well as the morphology of the surface of the quartz grain in separate fractions.

On the photographs taken of one preparation generally 500 grains of the fraction 0.1-0.02 mm were found. For fractions 0.02-0.01 and 0.01-0.005 mm 100 grains were examined for each fraction. The analysis was thus carried out on the basis of 700 quartz grains for one sample.

The greatest amount of grains occurs in the fraction 0.03—0.02 mm and 0.03-0.04 mm. That is the result of keeping the proportions imposed by the granulometric composition of the given silt material.

Grains exceeding 0.01 mm in diameter have not been considered. Very few grains of that size occur in the material investigated and they are not characteristic of loesses. Moreover, it was very difficult to take microphotographs of these large quartz particles. To examine fractions exceeding 0.1 mm in diameter, it would be necessary to use a different scale of microscopic augmentation, or examine them separately. In this case the weakness of the image makes it impossible to get a readable photograph. For grains in fractions exceeding 0.6 mm in diameter the method proposed by Morawski (4) may be used (this method was worked out for sands).

The degree of rounding of the quartz grains was established by a division into three principal types:

1) angular grains which show no marks of mechanical rounding processes,

2) partly rounded grains with at least one rounded side,

3) rounded grains round or oval with all the sides rounded and convex.

Within these three principal types, the grains were differentiated according to their surface. Two categories of grains were distinguished: 1) grains with a smooth, shining surface, and 2) grains with a rough surface. It was found by means of microscopic observation that an unpolished grain, when considerably enlarged, presented a surface full of numerous minute holes. So an unpolished grain is one with a rough surface.

To check the accuracy of the method used, a number of control counts were made. In order to compare the results, the counts made on photographs and directly under the microscope were repeated. The differences obtained were relatively small, and did not go beyond a possible mistake. Such a mistake may be made as a result of hesitation in placing a grain in the right category. The right interpretation of the microphotograph is much easier in the case of previous direct observation of the preparations under the microscope. This is also a great help later in the reading of the photographs.

By means of the above mentioned method 19 samples of loess and other silt materials from different areas of Poland were examined. Eleven samples were taken from the loess profile which is considered by many scientists (2) to be a profile of typical loess. This is the profile from Szczebrzeszyn (Lublin Upland) which is 11 metres thick. The samples were taken at 1 metre intervals, from the chalk substratum up to the top.

Samples were also taken from the profile of silt materials in Dybawka near Przemyśl. The silt material of this profile macroscopically resembles loess. Five samples taken at perpendicular 2 metre intervals were then examined microscopically.

Samples taken from three other profiles of silt materials were also analysed for comparison. One of the samples consists of material from the middle part of a 10 metre loess profile, which is an autcrop in the terrace of the Wieprz valley at Izbica. A sample from Brochocim Trzebnicki (Silesia) represents the „typical" loess (8) of the Trzebnica Hills; it was taken at a depth of 3.5 m. The silty material from the environs of Przeworsk was taken from the tile-works in the village of Łopuszka Wielka.

The data obtained by means of microscopic analysis present the character of separate samples of the whole profile. The percentage of different morphological types of quartz grains within the fractions 0.005—0.1 mm is shown in the table below.

Table 1. The percentage of different morphological types of quartz grains. (fractions 0.005—0.1 mm)

Locality	Angular grains in %		Partly rounded grains in %		Rounded grains in %	
	Smooth surface	Rough surface	Smooth surface	Rough surface	Smooth surface	Rough surface
Szczebrzeszyn Average of 11 samples	32.50	17.76	11.91	13.26	11.64	13.11
Dybawka Average of 5 samples	44.51	19.97	11.42	9.27	8.53	6.30
Izbica	32.24	18.66	14.15	17.19	10.98	8.78
Brochocim Trzebn.	45.39	15.18	14.73	10.86	10.42	3.42
Łopuszka Wlk.	34.15	14.69	15.25	12.97	13.83	9.08

In the case of the Szczebrzeszyn profile, the deviations of the percentage values from the average shown in the table oscillate within the narrow limits of 2 to 5%. For the silt material from the Dybawka profile the oscillations are smaller: 1 to 4%.

These values, being regarded as characteristic, were taken as a basis for further interpretation. From the data given in the table the prevalence of the sharp-edged smooth grains over other kinds of quartz grains is apparent. The material from the loess profile in Szczebrzeszyn shows the smallest oscillation. It possesses a relatively small percentage of an-

Diagram 1. Rounding of the quartz grains of the fraction 0.005—0.1 mm; A — sharp-edged grains, PR — partly rounded grains, R — rounded grains, 1 — Szczebrzeszyn, 2 — Dybawka, 3 — Izbica, 4 — Brochocim Trzebnicki, 5 — Łopuszka Wielka.

Wykres 1. Obróbka ziarn kwarcu frakcji 0,005—0,1 mm; A — ziarna kanciaste, PR — ziarna częściowo obtoczone, R — ziarna obtoczone, 1 — Szczebrzeszyn, 2 — Dybawka, 3 — Izbica, 4 — Brochocim Trzebnicki, 5 — Łopuszka Wielka.

gular smooth grains, and, in relation to other samples, a high percentage of rounded, rough ones.

The diagram below shows different characteristics for the different profiles. This diagram was based on the percentage contents of the successive samples of sharp-edged, partly rounded and rounded grains in each of the samples (diagram 1).

The lines connecting the points corresponding to the percentage values of the three types of grains, possess a different course for each profile. The individual character of the profile in Szczebrzeszyn and Dybawka can be clearly seen. The loess-like material of Dybawka contains an average of 64.48% of sharp-edged quartz particles, while in Szczebrzeszyn the same kind of grains amounts to 49.98%. The loess of Szczebrzeszyn, on the other hand, contains a greater amount of partly rounded and rounded grains than the Dybawka material.

Szczebrzeszyn — partly rounded grains — 25.42%
Dybawka — partly rounded grains — 20.77%
Szczebrzeszyn — rounded grains — 24.85%
Dybawka — rounded grains — 14.83%

The curves for the remaining samples either resemble those for Szczebrzeszyn (Izbica, Łopuszka) or those for Dybawka (Brochocim Trzebnicki). However, each of these curves shows some deviations from the average for Szczebrzeszyn or Dybawka.

The mutual relation between the three above-mentioned types of grains in the separate fractions varies greatly in successive samples from the same profile (Table 2). Certain regularities can, however, be observed when the results of the analysis of samples belonging to the same profile are compared. Thus the Szczebrzeszyn profile shows the maximum amount of sharp-edged particles in the fraction 0.005—0.01 mm (an average of 54.19%), while the maximum amount of rounded grains belongs to the fraction 0.04—0.05 mm (an average of 27.24%). In the Dybawka profile the greatest percentage of sharp-edged particles is contained in the fraction 0.02—0.03 mm (an average of 71.00%), while the maximum amount of rounded grains belongs to the fraction 0.05-0.1 mm (an average of 20.87%).

In the Izbica sample, like that of Szczebrzeszyn, the fraction 0.005—0.01 mm contains the greatest amount of sharp-edged quartz particles (52.00%), but the highest percentage of rounded grains occurs in the fraction 0.005-0.02 mm (28.00%). In the loess sediments of Brochocim Trzebnicki and Łopuszka the maximum amount of sharp-edged quartz particles belongs to the fraction of 0.005—0.2 mm (67.50 and 56.69%) while for the rounded grains it occurs in the fractions 0.005—0.02 mm

Table 2. The percentage of different morphological types of quartz grains in separate fractions (values given in %)

Locality	0,005 - 0,01			0,01—0,02			0,02—0,03			0,03—0,04			0,04—0,05			0,05—0,1		
	A	PR	R	A	PR	R	A	PR	R	A	PR	R	A	PR	R	A	PR	R
Szczebrzeszyn Average of 11 samples	54,19	22,27	23,54	50,73	25,73	23,55	50,83	23,99	25,07	48,16	26,67	24,24	47,05	25,53	27,24	44,36	28,28	26,40
Dybawka Average of 5 samples	65,00	18,20	16,80	58,80	26,00	15,00	71,00	16,19	12,81	62,60	23,23	13,87	58,04	26,12	15,86	54,74	24,38	20,87
Izbica	52,00	20,00	28,00	46,00	26,00	28,00	49,67	31,04	19,28	45,20	33,56	21,24	50,00	40,63	9,37	51,41	38,88	9,72
Brochocim Trzebnicki	54,00	22,00	24,00	42,00	32,00	26,00	67,50	22,14	10,36	67,27	28,05	4,67	59,31	32,21	8,48	57,69	26,92	15,39
Łopuszka Wlk.	44,00	28,00	28,00	40,00	32,00	28,00	56,69	19,37	23,94	45,35	33,72	20,93	42,19	39,06	18,75	48,65	37,84	13,51

A — angular grains, PR — partly rounded grains, R — rounded grains

(26.00 and 28.00%). Partly rounded grains reach their maximum amount, in all samples, in the fraction 0.04—0.05 mm.

In order to compare the mutual relations between the volumes of the separate fractions, a diagram of the granulometric composition of all the samples has been drawn. It is based on the results of the mechanical analysis carried out by the method of Cassagrande, modified by Prószyński (5) (diagram 2).

The results of the microscopic analyses lead to the following conclusions:

The present investigations have proved that the quartz particles undergo a mechanical change even if they are 0.005 mm in diameter.

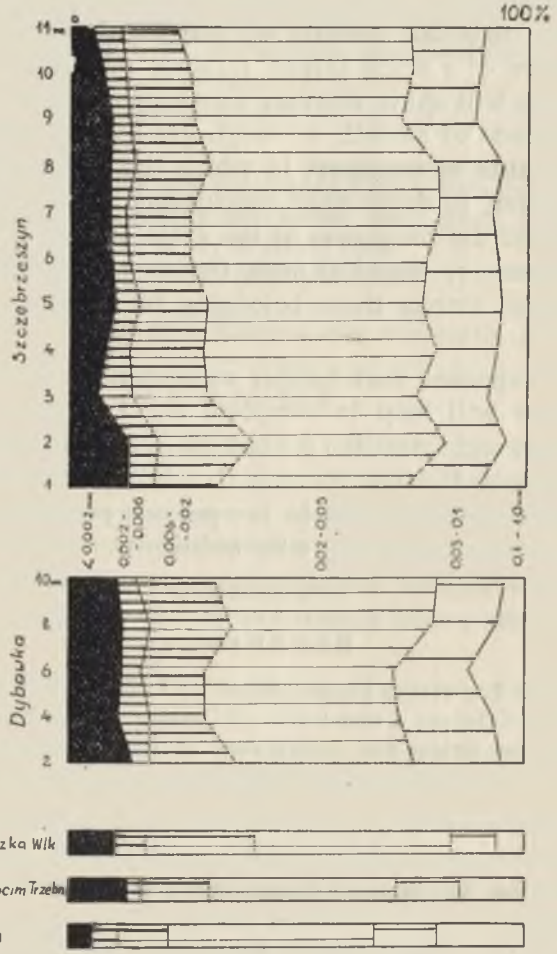

Diagram 2. The granulometric constitution of the loess and loesslike materials.
Wykres 2. Diagram składu granulometrycznego lessu i utworów pylastych lessopodobnych.

The degree of mechanical change in the quartz particles shows different values for the different sediments. In one profile, the values determining the mutual percentage relations between sharp-edged, partly rounded and rounded grains, oscillate within very narrow limits. These values therefore characterize the sedimentological properties of the formations making up the actual profiles.

On this basis it might be possible to perceive similarities or differences between loess and loess-like formations. The percentage of the content of rounded and partly-rounded grains in a given sample may indicate the distance from which silty material has been transported. Some information might be also obtained, regarding the character of the environment from which the quartz particles came before they entered into the materials making up the pleistocene, geological profile. The examination of a much larger number of samples from different silty formations will show whether this supposition is true.

The prevalence of smooth or rough grains may be a certain indication as to the kind of transport to which the silt was subjected. It is difficult, however, to draw clear conclusions because it is impossible to find out whether the roughness of the grain surface is the result of mechanical processes, or chemical ones. Grains with a rough surface sometimes occur even among those belonging to fractions of the smallest diameter.

It may be supposed that further examinations of the morphology of quartz particles will help to complete our knowledge of the physical features of loess and loess-like formations. They will also contribute new information about the environmental relations which determined the shape of quartz particles (silt) in the periods preceding their accumulation in the horizons composing silty sediments.

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РЕЗЮМЕ

Одним из важных, недооцениваемых в исследованиях свойств лёссов, является морфология кварцевого зерна. В многочисленных работах, посвященных лёссовым отложениям, форме зерна не придавалось, обычно, должного внимания. По мнению одних авторов зерна кварца ниже определённого размера не подвергаются механической обработке. Другие констатируют наличие окатанных зерен диаметром даже 0,003 мм (10).

Морфологией кварцевых зерен лёссов Подолья занимался основательно проф. Токарски (13). Применяя в своих исследованиях микроскопический анализ, он признает отсутствие закономерности относительно числа и размеров окатанных частиц.

Большим затруднением в сопоставлении результатов исследований разных авторов является отсутствие более точных количественных данных, определяющих взаимное соотношение зерен с разной степенью окатанности. Автор сделал попытку произвести анализ морфологии кварцевых зерен в лёссовых отложениях. Цель анализа — обнаружить окатанные зерна кварца а также их отношение к неокатанным зернам в отдельных фракциях. Дальнейшей задачей было

определение на этом основании различий или сходства между так называемыми типичными лёссами и пылеватыми отложениями похожими на лёссы.

С этой целью проводились микроскопические анализы проб из разных пылеватых отложений. В исследованиях зерен фракции 0,1—0,02 мм были использованы микрофотографии пылистых препаратов увеличенных в 500 раз. Зёрна диаметром 0,02—0,005 мм наблюдались непосредственно под микроскопом с увеличением в 1500 раз. Фракции зерен больше 0,1 мм и меньше 0,005 мм как нетипичные для лёссов не исследовались. На 10 микрофотографиях из каждой пробы проводились измерения размеров, степени окатанности и морфологии поверхности зерен. Вместе с непосредственными микроскопическими наблюдениями было проанализировано около 700 зерен кварца из одной пробы.

Для характеристики степени окатанности зерен выделены три типа зерен: 1 — зерна неокатанные, 2 — зерна частично окатаные и 3 — зерна окатанные. Выделены также две категории зерен относительно характера их поверхности: а) — зерна с гладкой поверхностью и б) — зерна с шороховатой поверхностью.

Методом микрофотографии иследованы 19 проб лёсса и других лёссовидных отложений. Полученные таким образом количественные данные представляют характеристику отдельных проб или профилей целых разрезов. Процентное содержание разных морфологических типов зерен кварца для фракции 0,005—0,1 мм представляет таблица (табл. 1). В случае лёссового разреза (типичного лёсса) из Щебжешина а также пылеватых отложений из Дыбавки у г. Пшемысля учитывались средние величины. Представилось возможным использовать средние величины вследствие малых различий между пробами, взятыми из одного разреза.

Основываясь на процентное содержание в пробах: неокатанных, частично окатанных и окатанных зерен, сделана диаграмма, образующая разные характерные признаки отдельных разрезов (диаграмма 1). Количественное соотношение разных типов зерен в пробах из различных разрезов очень изменчиво. Наоборот, в пробах, взятых из одного разреза, колебания количества зерен разной степени окатанности небольшие. Взаимное соотношение трех вышеупомянутых типов зерен в отдельных фракциях представляется поразному для одного разреза (табл. 2). Однако, можно уловить некоторые закономерности сопоставляя пробы из одного разреза. Можно констатировать, что для каждого из рассматриваемых разрезов характерной является иная фракция, содержащая максиммальное количество зерен окатанных, частично окатанных или неокатанных.

Объемные соотношения отдельных фракций представлены в виде диаграммы гранулометрического состава всех проб (диаграмма 2).

Итоги морфологических исследований зерен кварца можно составить в виде следующих выводов:

Зерно кварца подвергается обработке даже при диаметре 0,005 мм.

Величины, определяющие взаимное процентное соотношение зерен окатанных, частично окатанных и неокатанных, разные для отдельных разрезав, но очень близкие в одном разрезе.

Учитывая процентное содержание окатанных или частично окатанных зерен можно судить о дальнем или близком транспорте пылеватого материала.

Расширение этого типа исследований может помочь определить различия между лёссами и отлжоениями, напоминающими лёсс.

Диаграмма 1. Окатанность зерен кварца фракции 0,005—0,1 мм; A — неокатанные зерна, PR — частично окатанные зерна, R — окатанные зерна, 1 — Щебжешин, 2 — Дыбавка, 3 — Избица, 4 — Брохоцим Тшебницки, 5 — Лопушка Велька.

Диаграмма 2. Диаграмма гранулометрического состава лёсса и пылеватых лёссовидных отложений.

Фот. 1. Остроугранное зерно кварца (фракция 0,02—0,03 мм).

Фот. 2. Частично окатанное зерно кварца (фракция 0,02—0,03 мм).

Фот. 3. Окатанное зерно кварца (фракция 0,02—0,03 мм).

Фот. 4. Фотография препарата пробы лёсса из глубины 9 м (Щебжешин) — увеличение 250 раз.

Фот. 5. Фотография препарата пробы лёсса из глубины 7 м (Дыбавка) — увеличение 250 раз.

STRESZCZENIE

Jedną z ważnych, a w dotychczasowych badaniach nie zawsze docenianą własnością fizyczną lessów jest morfologia ziarna kwarcowego. W licznych rozprawach, poświęconych utworom lessowym, rola wykształcenia ziarna potraktowana jest zwykle marginesowo. Zdaniem jednych autorów ziarno kwarcu poniżej pewnej wielkości nie podlega obróbce mechanicznej. Inni zaś stwierdzają występowanie ziarn obtoczonych nawet o średnicy 0,003 mm (10).

Morfologią ziarn kwarcowych z lessów Podola zajął się bliżej prof. J. Tokarski (13). Stosując w swych badaniach analizę mikroskopową, uznaje brak prawidłowości odnośnie liczby i wielkości obtoczonych ziarn.

Dużą trudnością w porównaniu wyników badań różnych autorów jest brak dokładniejszych danych liczbowych, które określałyby wzajemny stosunek ziarn o różnym stopniu obtoczenia. Autor podjął próbę dokonania szczegółowej analizy morfologii ziarn kwarcowych w utwo-

rach lessowych. Wyniki tej analizy miały wykazać występowanie obtoczonych ziarn kwarcu oraz ich stosunek względem ziarn ostrokrawędzistych w poszczególnych frakcjach. Dalszym zadaniem było stwierdzenie na tej podstawie różnic względnie podobieństw między lessami tzw. typowymi i utworami pylastymi podobnymi do lessu.

W tym celu zostały wykonane analizy mikroskopowe próbek pochodzących z różnych utworów pylastych. W badaniach ziarn frakcji 0,1—0,02 mm wykorzystano mikrofotografie preparatów pyłowych przy zastosowaniu 500-krotnego powiększenia. Ziarna o średnicy 0,02—0,005 mm poddano bezpośredniej analizie mikroskopowej (powiększenie 1500 ×). Frakcje ziarn większych od 0,1 mm oraz mniejszych od 0,005 mm, jako nietypowe dla lessów, zostały pominięte. Na 10 mikrofotografiach z każdej próbki, wykonywano pomiary wielkości, stopnia obtoczenia i morfologii powierzchni ziarn. Łącznie z bezpośrednimi obserwacjami mikroskopowymi rozpatrywano około 700 ziarenek kwarcu dla jednej próbki.

Dla charakterystyki stopnia obtoczenia ziarn wydzielono trzy typy ziarn; 1) ziarna kanciaste, 2) ziarna częściowo obtoczone i 3) ziarna obtoczone. Zróżnicowano również ziarna pod względem ich powierzchni, wydzielając dwie kategorie: a) ziarna o powierzchni gładkiej i b) ziarna o powierzchni chropowatej.

Stosując metodę analizy mikrofotograficznej, przebadano 19 próbek lessu i innych utworów pylastych przypominających less. Uzyskane tą drogą dane liczbowe przedstawiają charakterystykę poszczególnych próbek względnie całych profilów. Procentowy udział różnych typów morfologicznych ziarn kwarcu dla frakcji 0,005—0,1 mm przedstawiono w tabeli (tab. 1). W przypadku profilu lessowego (tzw. less typowy) ze Szczebrzeszyna oraz profilu utworów pylastych z Dybawki k. Przemyśla posłużono się wartościami średnimi. Możliwość wykorzystania wartości średnich wynikła z małych różnic pomiędzy kolejnymi próbkami wziętymi z wymienionych profilów.

W oparciu o zawartość procentową w próbkach ziarn kanciastych, częściowo obtoczonych i obtoczonych sporządzono diagram obrazujący cechy charakterystyczne poszczególnych profilów (diagram 1). Stosunek ilościowy ziarn różnych typów w próbkach pochodzących z odrębnych profilów wykazuje znaczne zróżnicowanie. Natomiast w próbkach wchodzących w skład jednego profilu wahania ilości ziarn w różnym stopniu obtoczonych są nieznaczne. Wzajemny stosunek trzech wyżej wymienionych typów ziarn w poszczególnych frakcjach układa się różnie w kolejnych próbkach tego samego profilu (tab. 2). Jednakże pewnych prawidłowości można się doszukać, zestawiając próbki z jednego profilu. Stwierdzić można, że dla każdego z rozpatrywanych pro-

filów charakterystyczna jest inna frakcja, zawierająca maksymalną ilość ziarn obtoczonych, częściowo obtoczonych względnie obtoczonych.

Stosunki objętościowe poszczególnych frakcji przedstawione zostały w postaci diagramu składu granulometrycznego wszystkich próbek (diagram 2).

Wyniki badań morfologii ziarn kwarcu można ująć w następujących wnioskach:

Ziarno kwarcu podlega obróbce nawet przy średnicy 0,005 mm.

Wartości określające wzajemny stosunek procentowy ziarn kanciastych, częściowo obtoczonych i obtoczonych są różne dla odrębnych profilów, zaś bardzo zbliżone w obrębie jednego profilu.

W oparciu o procentową zawartość ziarn obtoczonych względnie częściowo obtoczonych można sądzić o dalekim lub bliskim transporcie materiału pyłowego.

Rozszerzenie badań tego typu może dopomóc w określeniu różnic między lessami i utworami przypominającymi swym wyglądem less.

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Fig. 1. Sharp-edged quartz grain (fraction 0.02—0.03 mm).
Fot. 1. Kanciaste ziarno kwarcu (frakcja 0,02—0,03 mm).

Photo by Author

Fig. 2. Partly rounded quartz grain (fraction 0.02—0.03 mm)
Fot. 2. Częściowo obtoczone ziarno kwarcu (frakcja 0,02—0,03 mm).

Photo by Author

Fig. 3. Rounded quartz grain (fraction 0.02—0.03 mm).
Fot. 3. Obtoczone ziarno kwarcu (frakcja 0,02—0,03 mm)
Photo by Author

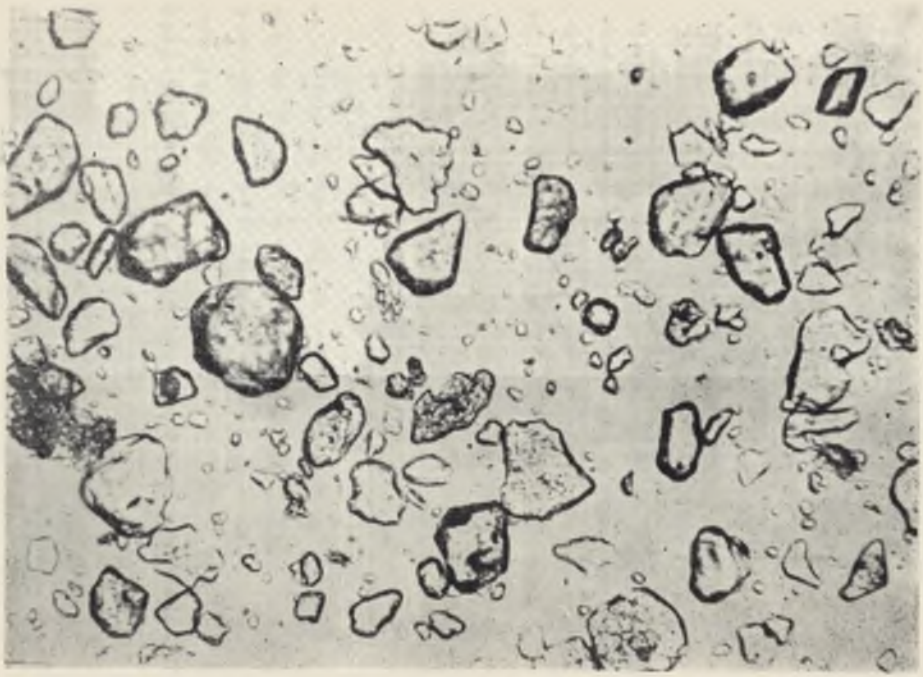

Fig. 4. Loess sample preparation from the depth of 9 m (Szczebrzeszyn), magnification 250 ×
Fot. 4. Preparat próbki lessu z głębokości 9 m (Szczebrzeszyn) — powiększenie 250 ×.
Photo by Author

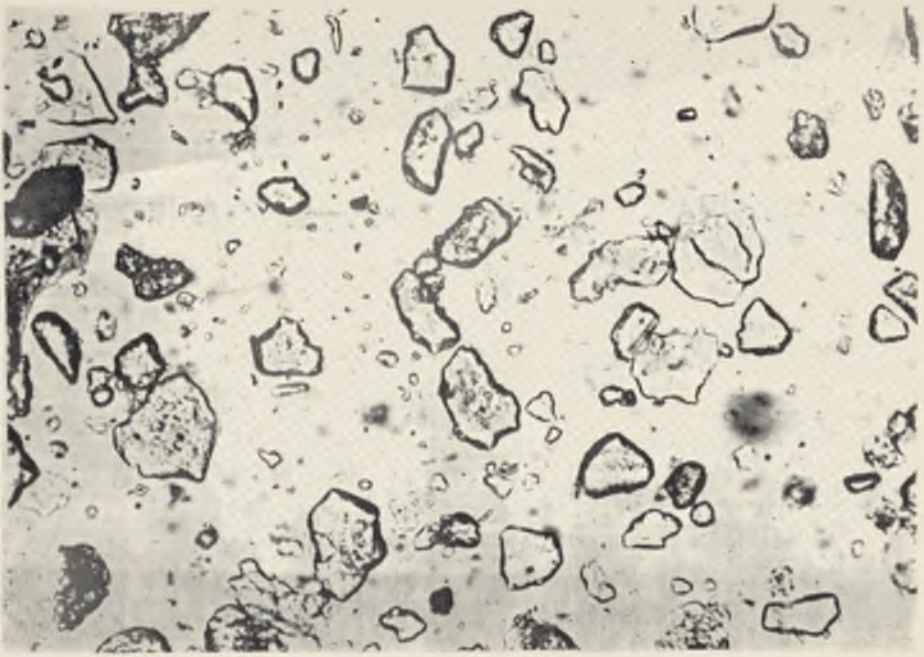

Fig. 5. Loesslike material sample preparation from the depth of 7 m (Dybawka) — magnification 250 ×

Fot. 5. Preparat próbki utworu lessopodobnego z głębokości 7 m (Dybawka) — powiększenie 250 ×.

Photo by Author

Jerzy Butrym