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THE MINERALOGICAL COMPOSITION AND CONDITIONS OF SEDIMENTATION OF THE LACUSTRINE DEPOSITS IN THE HIGH TATRA MOUNTAINS (POLAND)

In this paper further results of research on lacustrine deposits revealed in the High Tatra Mts are presented. Studies were carried out under the direction of M. Baumgart-Kotarba and A. Kotarba. The samples of deposits have been taken from four shallow borings sunken in the lakes Zielony Staw Gąsienicowy and Czarny Staw Gąsienicowy, and from the bottom of the Czerwony Staw Lake occurring in the Gąsienicowa Valley (Fig. 1). The detailed description of the boring techniques and the first research results (content of organic substance, sedimentological structure, density, grain size distribution) have already been presented by Baumgart-Kotarba, Jonasson and Kotarba (1990).

This paper contains an analysis of the mineralogical composition of lacustrine deposits. It also tries to explain the mechanism of material sedimentation in the lakes.

RESEARCH METHOD

Analysis of the mineralogical composition of samples was made in two fractions: 0.125 mm and 0.125—0.063 mm. The following minerals have been distinguished: muscovite, biotite, quartz, plagioclase, alkalic feldspar and others. Calcite, garnet, very well rounded quartz grains as well as fragments of granitoids, limestones, quartzitic sandstones, mylonites were classified as "others". The roundness of muscovite grains greater than 0.125 mm was also determined using the model scale by Pettijohn (1975). Among the minerals distinguished only micas varied in the roundness degree. A binocular microscope was used to analyse 300 grains. Magnification was 25—72.5 times. Results of the mineralogical composition are presented along with the diagrams show-

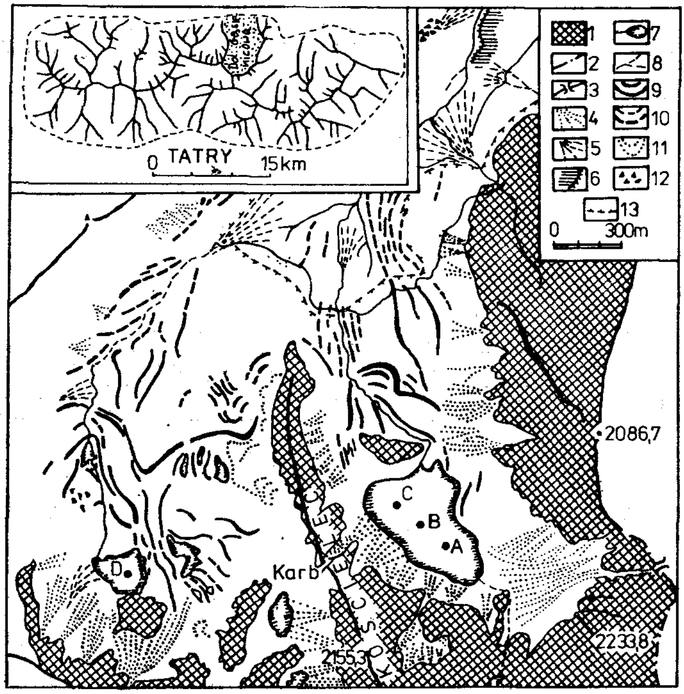


Fig. 1. Geomorphological sketch to show the upper part of the Gąsienicowa valley containing the Czarny Staw Gąsienicowy Lake (location of sample sites A, B, C) and the Zielony Staw Gąsienicowy Lake (location of sample site D) (by Baumgart-Kotarba *et al.* 1990): 1 — rock walls and rocky slopes, 2 — summit, 3 — pass, 4 — talus cone, 5 — alluvial cone, 6 — terrace, 7 — lake, 8 — periodical stream, 9 — younger moraine ridges, 10 — older moraine ridges, 11 — rock glaciers, 12 — blockfields, 13 — upper tree line

Ryc. 1. Szkic geomorfologiczny górnej części doliny Gąsienicowej pokazujący położenie Czarnego Stawu Gąsienicowego (miejsca poboru prób A, B, C) i Zielonego Stawu Gąsienicowego (próba D) (Baumgart-Kotarba *et al* (1990): 1 — ściany i stoki skalne, 2 — wierzchołek, 3 — przełęcz, 4 — stożek usypiskowy, 5 — stożek napływowy, 6 — terasa, 7 — jezioro, 8 — potok okresowy, 9 — wały morenowe młodsze (A), 10 — wały morenowe starsze (B), 11 — lodowiec gruzowy, 12 — pola blokowisk, 13 — górna granica lasu

ing grain size distribution which were constructed by Baumgart-Kotarba *et al.* (1990).

The analysis of sediment obtained from the bottom of the Czerwony Staw Lake was also made. This sample was collected in the place, where sedimentation from suspension was dominant. It was taken after several months which passed from the heaviest rainfall noted in the last one hundred years.

THE CZERWONY STAW LAKE

The sample taken from the bottom of the Czerwony Staw Lake is a suspended sediment (Fig. 2). Within the grain size distribution silt and clayey fractions are clearly dominant (nearly 90%). The mineralogical composition of the sandy fraction is characterized by the high percentage of micas (up to 45%). These decrease in number with increasing grain size. Muscovite being most often represented in the sample shows a mean roundness degree. The presence of numerous limestone grains is interesting since they are foreign material to the catchment basin of this lake. These grains were probably transported by the wind.

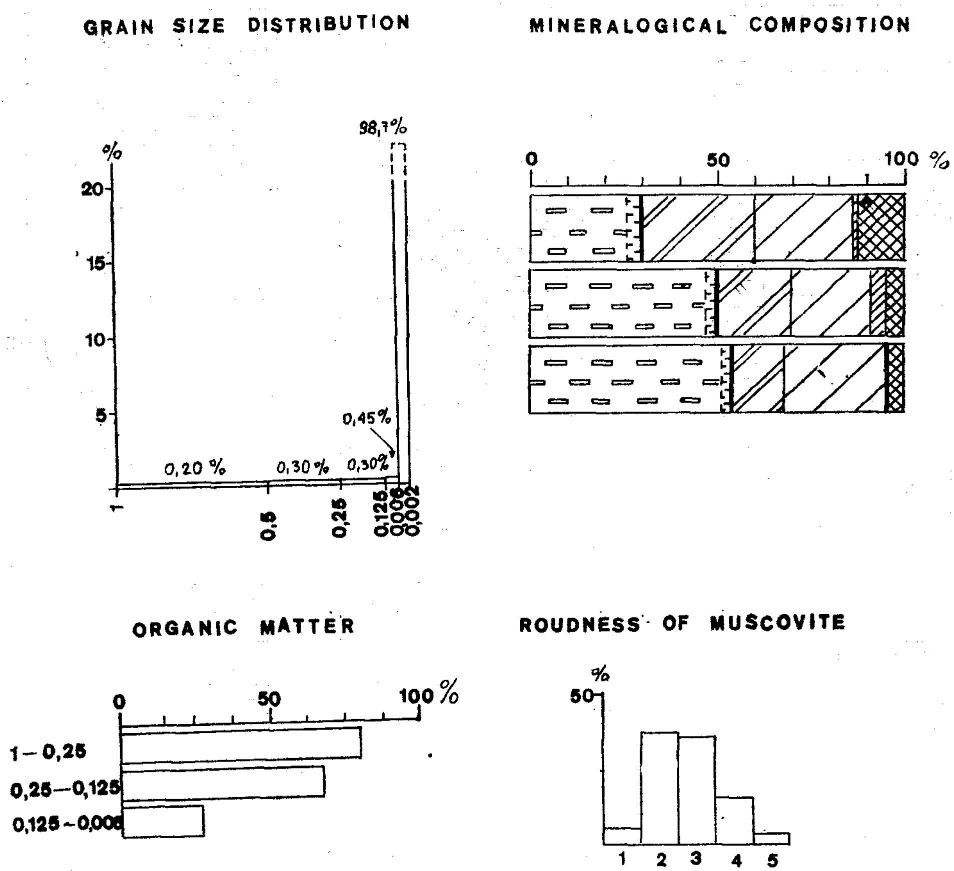


Fig. 2. Grain size distribution, mineralogical composition, organic substance content and roundness of muscovite grains in the fraction 0.125 in the suspended material taken from the Czerwony Staw Lake. For explanations see Fig. 3

Ryc. 2. Analiza uziarnienia, skład mineralny, zawartość materii organicznej oraz obtoczenie muskowitu we frakcji >0,125 mm w osadach z zawiesiny w Czerwonym Stawie. Objaśnienia na Ryc. 3

The main components of the sediment are minerals contained in the crystalline rocks which dominate in the catchment basin of the lake discussed. The original features of composition of the parent rocks are reflected in the nature of the lacustrine deposits (Fig. 3). These

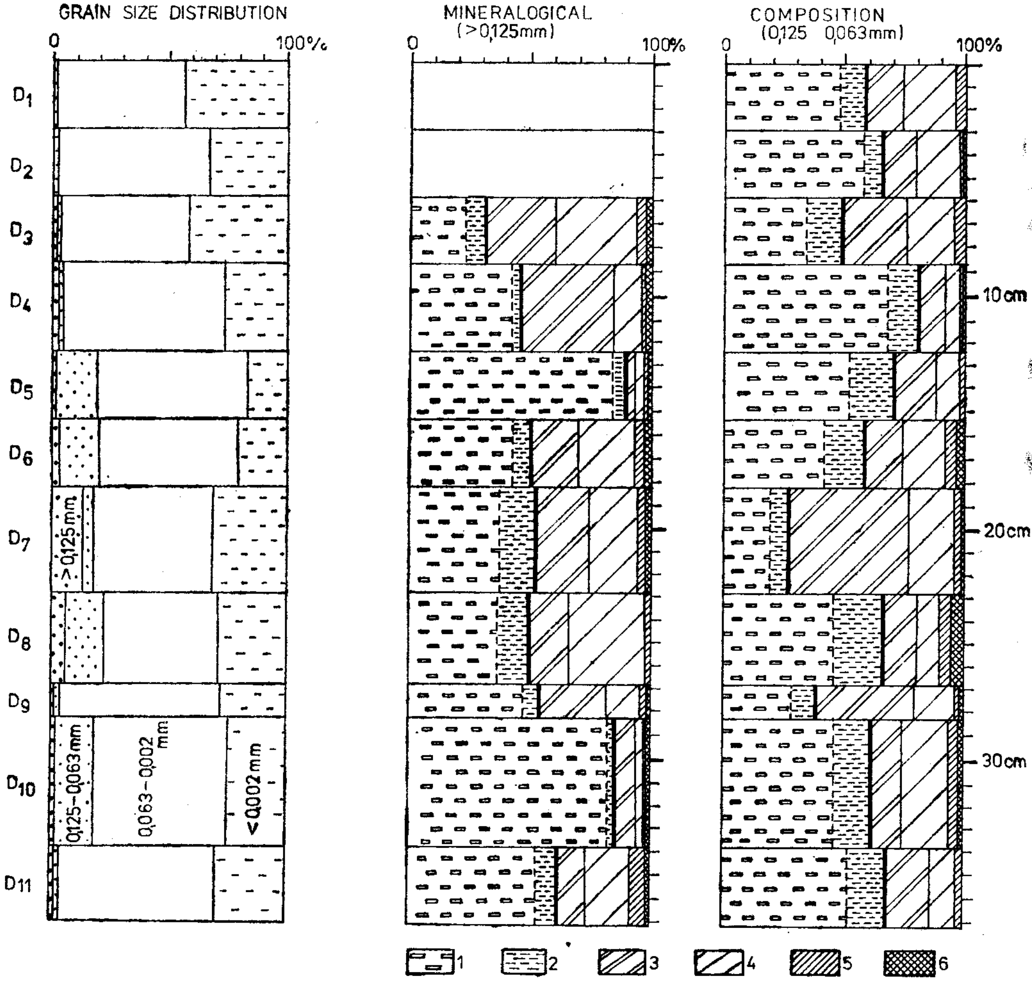
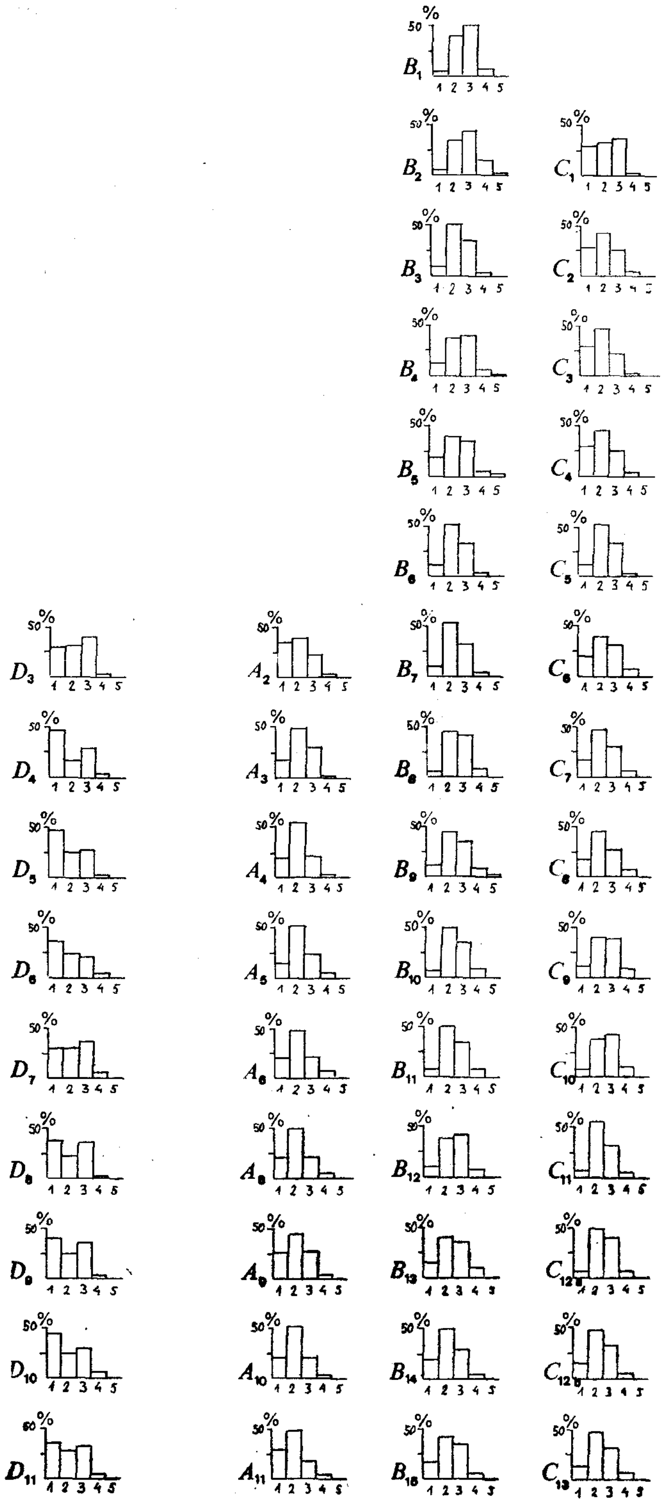


Fig. 3. Grain size distribution (by Baumgart-Kotarba *et al.* 1990) and mineralogical composition of deposits in core D, the Zielony Staw Gąsienicowy Lake: 1 — muscovite, 2 — biotite, 3 — quartz, 4 — plagioclase, 5 — alkalic feldspar, 6 — other minerals

Ryc. 3. Rozkład uziarnienia (Baumgart-Kotarba *et al.* (1990) oraz skład mineralny osadów w rdzeniu D, Zielony Staw Gąsienicowy: 1 — muskowit, 2 — biotyt, 3 — kwarc, 4 — plagioklaz, 5 — skaleń alkaliczny, 6 — inne

Fig. 4. Roundness of muscovite grains in the Zielony Staw Gąsienicowy Lake (core D) and in the Czarny Staw Gąsienicowy Lake (cores A, B, C), according to Pettijohn's scale (1975)



Ryc. 4. Stopień obtoczenia muskowitu w Zielonym Stawie Gąsienicowym (D) oraz w Czarnym Stawie Gąsienicowym (A, B, C), wg skali Pettijohna (1975)

features are as follows: predominance of muscovite over biotite in the micas, quartz content about 20% and a very low content of alkalic feldspars (about 3%). However, a macroscopic analysis revealed their lower real number.

The ratio of the particular minerals deviates from the original composition of the parent rocks. The mineralogical composition of the sediments obtained from the Zielony Staw Gąsienicowy Lake is marked

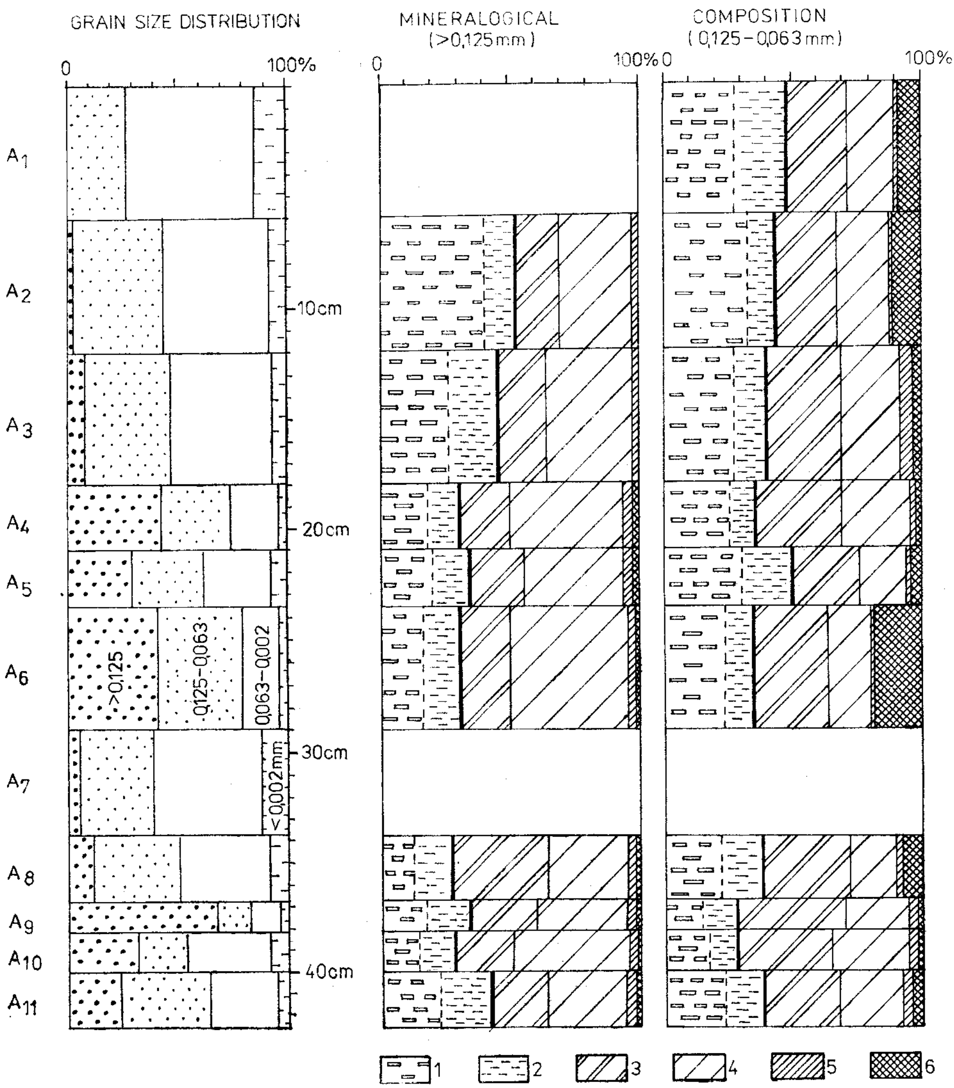


Fig. 5. Core of the boring A, Czarny Staw Gąsienicowy Lake. Explanations are as for Fig. 3

Ryc. 5. Rdzeń z wiercenia A, Czarny Staw Gąsienicowy. Objaśnienia na Ryc. 3

by the high percentage of micas (mean 58%) in all cores. Micas are especially abundant in the samples D_5 and D_{10}. They are characterized by a low roundness degree of muscovite (over 45% of angular grains) (Fig. 4). This feature of the lacustrine deposits examined is unlike those of the other cores. The distribution of the roundness of muscovite grains is bimodal. The samples D_5 and D_7 contain grains of red quartzitic sandstones which outcrop on the crest of the Skrajna Turnia Mt. In this part of the profile they can, therefore, be an indicator of material supply into the lake from a western direction.

THE CZARNY STAW GĄSIENICOWY LAKE (CORES A, B, C)

The catchment basin of the Czarny Staw Gąsienicowy Lake is underlain only by crystalline rocks. The sediments are, therefore, composed of minerals derived only from igneous rocks. All of the profiles (A,

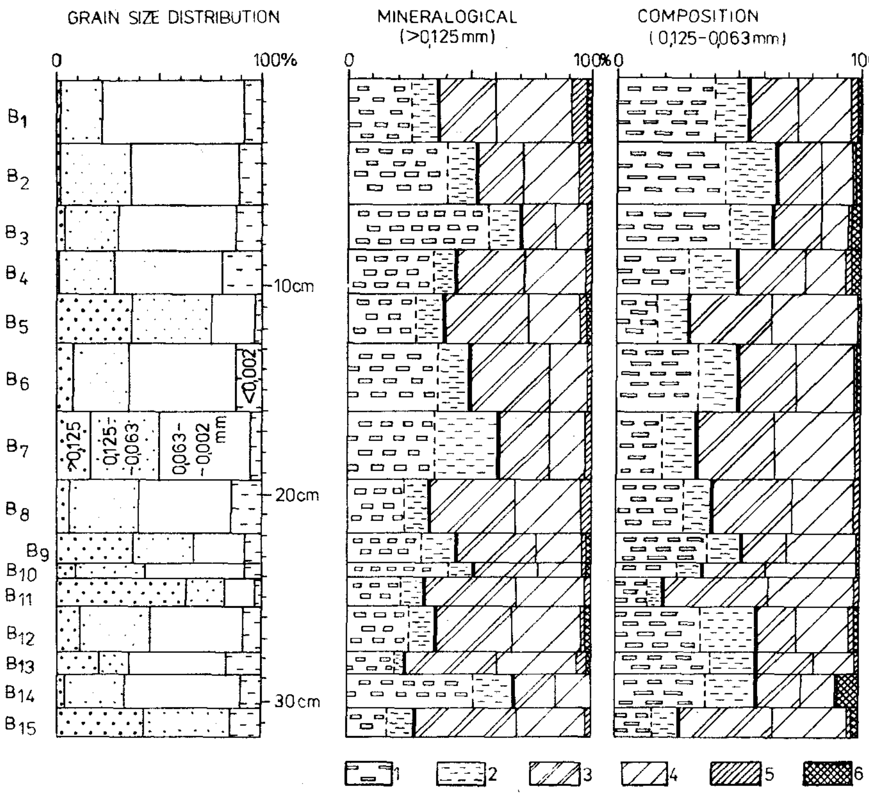


Fig. 6. Core of the boring B, Czarny Staw Gąsienicowy Lake. Explanations are as for Fig. 3

Ryc. 6. Rdzeń z wiercenia B, Czarny Staw Gąsienicowy. Objaśnienia na Ryc. 3

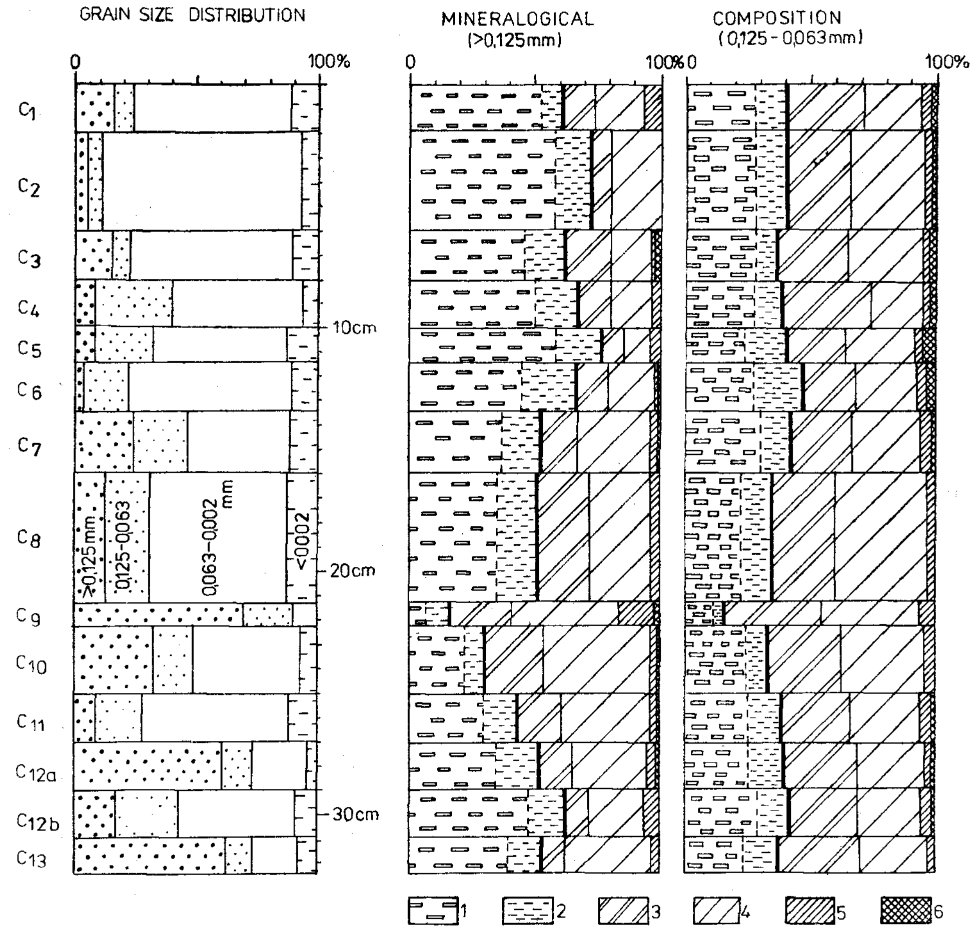


Fig. 7. Core of the boring C, Czarny Staw Gąsienicowy Lake. Explanations are as for Fig. 3

Ryc. 7. Rdzeń z wiercenia C, Czarny Staw Gąsienicowy. Objaśnienia na Ryc. 3

B, C) are characterized by a higher content of both quartz and feldspar and by a lower mica content than those in the Zielony Staw Gąsienicowy Lake (Fig. 5, 6, 7). Another feature is the greater roundness degree of muscovite (unimodal distribution). The core B is marked by the highest variability of the mineralogical composition in both analysed fractions. It reflects changes in the grain size composition. The higher the content of the sandy fraction the higher is the quartz and feldspar content. This feature is especially seen in layers containing more than 80% of the sandy fraction, for example, B_5, B_{11}, B_{15}, C_9, A_5, A_9. Another rule is characteristic of the cores C and A. Independently of the grain size distribution, the mineralogical composition in the fraction 0.125—0.063 mm is marked by a constant content of micas (39% in core A, 45% in core B_9), and by a very similar number of other minerals. This points to the same type of grain transport in this fraction, probably in suspension. Moreover, the cores differ by the roundness degree of muscovite. In profile B the grains are best rounded, whereas in the core A (Fig. 4) the muscovite grains are least rounded. The fill of an erosional "hollow" (layer A_6) which was deposited by a turbidity current (viz. Baumgart-Kotarba *et al.* 1990) became confirmed by the mineralogical composition of the overlying strata (A_5—A_2). The content of micas showing a low specific gravity increases upward.

CONCLUSIONS

Both the mineralogical composition and the roundness degree of muscovite found in the lakes Czarny Staw Gąsienicowy and Zielony Staw Gąsienicowy indicate differences in the mechanism of sedimentation there. In the Zielony Staw Gąsienicowy Lake the high mica content which coincides with the low value of the sandy fraction confirms the lower energy of material supply into the central part of the lake. The more mineral layers being interpreted as turbidity deposits (Baumgart-Kotarba *et al.* 1990) are characterized by a higher quartz and feldspar content and by a greater roundness degree of muscovite. The more organic intercalations are marked by higher values of micas and by a very low roundness degree. These features may confirm the occurrence of periods of a quiet sedimentation, with respectively increasing aeolian transport into the lake. However, it is difficult to estimate its rate.

The more intensive material supply into the Czarny Staw Gąsienicowy Lake is indicated by high quartz and feldspar content (even up to 90%). In the profile, the content of micas in the fraction 0.125—0.063 mm can suggest a transport in suspension of this grain size. This is well seen in the cores A and C and confirmed by the nature of the present-day suspended material which was analysed at the model site, i.e. the Czerwony Staw Lake. The respectively high roundness degree of muscovite, together with the low content of organic layers rather contradicts the important role played by aeolian transport in the material supply into the lake.

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STRESZCZENIE

K. Bąk

SKŁAD MINERALNY ORAZ WARUNKI SEDYMENTACJI NAJMŁODSZYCH OSADÓW JEZIORNYCH W TATRACH WYSOKICH

Poniższe studia są kontynuacją badań osadów jeziornych w Tatrach Wysokich prowadzonych przez M. Baumgart-Kotarbę, C. Jonassona, A. Kotarbę (1990). Próbki pobrano z 4 płytkich wierceń w Zielonym Stawie Gąsienicowym i Czarnym Stawie Gąsienicowym oraz z powierzchni dna Czerwonego Stawu w dolinie Gąsienicowej (Ryc. 1).

Głównym składnikiem osadów w Czarnym i Zielonym Stawie Gąsienicowym są minerały skałotwórcze skał krystalicznych, które dominują w podłożu zlewni. Jednak stosunki ilościowe poszczególnych minerałów znacznie odbiegają od pierwotnego udziału w skale macierzystej. W obu jeziorach jest charakterystyczny wysoki udział mik. Wyróżnia on szczególnie osady Zielonego Stawu Gąsienicowego. W warstwach bardziej organicznych ich udział sięga do 90%, np. D_5, D_{10} (Ryc. 3), natomiast maleje stopień obtoczenia muskowitu (bimodalność rozkładu). Cechy te mogą świadczyć o okresach ze względnie większym udziałem transportu eolicznego do jeziora, trudnym jednak do oszacowania.

Osady Czarnego Stawu Gąsienicowego charakteryzują się wyższym udziałem

frakcji piaszczystej, która z kolei jest podkreślona poprzez wysoki udział w jej składzie kwarcu i skaleni (nawet do 90%). Jednakowy udział mik w całym profilu dla frakcji 0,125—0,063 mm może sugerować transport w zawiesinie dla ziarn tej wielkości. Jest to dobrze widoczne w rdzeniach A i C (Ryc. 5, 7). Potwierdzają to również cechy współczesnej zawiesiny, analizowanej na przykładzie Czerwonego Stawu (Ryc. 2). Transport eoliczny w dostawie materiału do tego jeziora nie odgrywa większej roli. Świadczy o tym stosunkowo wysoka wartość stopnia obtoczenia muskowitu (rozkład unimodalny), przy niskim udziale warstw bogatych w materię organiczną. Dominuje tu transport poprzez prądy grawitacyjne.