POLISH ACADEMY OF SCIENCES
INSTITUTE OF GEOGRAPHY

PRZEGLĄD GEOGRAFICZNY

POLISH GEOGRAPHICAL REVIEW

VOL. XXVIII. SUPPLEMENT

SPECIAL ISSUE
FOR THE XVIII-TH INTERNATIONAL GEOGRAPHICAL CONGRESS
RIO DE JANEIRO 1956

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STANISŁAW LESZCZYCKI

NATIONAL PLAN OF GEOGRAPHICAL RESEARCH IN POLAND 1956 TO 1960

The Polish Academy of Sciences prepared, in 1955, general directions for scientific work in Poland for Five-Year Plan 1956—1960. On that basis, the Academy's Geographical Institute worked out a national plan of geographical research. This plan lays down the tapes, so to speak, along which geographical research is to develop in Poland during the next five years. This is not an isolated plan, but the result of long years of effort to establish in Poland [1] the proper subject matter and methodology of geographical research.

Work on the planning of geographical research has been in progress for a number of years; planning has gradually become more efficient, and the subjects chosen have been coming closer and closer to the requirements of social-economic life, and of increasing importance in the further development of geography as a Marxist science.

After several years of preparations, work began in 1955 on actually outlining, for the period 1956 to 1960, a national plan of geographical research suited to the current resources of Polish geography as regards both personnel and material means.

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A prime essential to a further accelerated development of geographical studies in Poland is the linking of geographical research with the needs of social-economic life. Another indispensable condition is consistently to base such work on dialectical and historical materialism. The third condition is the concentration of effort on the study of a few, but the most important geographical problems.

Taking these premisses as a basis, twelve outstanding geographical problems, on which Polish geographers should concentrate their efforts, were fixed.

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[1] S. Leszczycki. *Kształtowanie się ogólnopolskiego planu badań geograficznych.* "Nauka Polska" (1955), No. 11, p. 41.
S. Leszczycki. *Plan badań geograficznych w Polsce na okres 1956 — 1960,* "Przegląd Geograficzny" (1956), No. 1.

I n p h y s i c a l g e o g r a p h y, it is desirable that investigations should tend towards as accurate as possible a study of the natural environment of Poland on the basis of the deep knowledge of its different components and of the processes taking place in it; as well as from the point of view of the possibilities of their economic utilization.

1. THE GEOMORPHOLOGY OF POLAND

Since 1950, all geographical departments in Poland have been working on a detailed geomorphologic map of the country (in 1 : 50 000). By 1955 an area of some 50.000 sq. km. had been mapped.

During the first two years, the greatest attention was given to the elaboration of methods of geomorphological investigation and mapping, consisting mainly in the registration of land relief forms. In the subsequent years, investigations were pursued with a view to solving the principal problem, that is, as regards geomorphology, the morphological development of the area investigated, its further trend of development, and mutual relationships with other elements of natural environment [2]. The Five-Year Plan provides for the mapping of a further 50.000 sq. km.

Irrespective of geomorphological mapping, further theoretical morphological work needs to be done on generalising the results obtained so far and on deepening the theoretical foundations of geomorphology. Here, there are two pressing problems. They concern the characteristic and the distribution of periglacial phenomena, and the denudation balance of slopes.

2. THE HYDROGRAPHY OF POLAND

The hydrographical mapping of all Poland has been in progress since 1952. It is intended to register all water phenomena in the area investigated. Some 30.000 sq. km. had been mapped by 1955, and the Five-Year Plan provides for the mapping of a further 50.000 sq. km. Geographers seek by means of detailed hydrographic surveys, to know water circulation in its mutual relationships with other elements of the natural environment in each river basin (even the smallest). This mapping also includes ground water [3].

3. LOCAL CLIMATE

The geographers' and meteorologists' 1954 conference, which dealt with climatic investigations, showed that studies on local climate have been particularly neglected, and at the same time are badly needed. Therefore, it was decided, during the Five-Year Plan, to concentrate geographers-climatologists' efforts on the elaboration of working methods concerning the local climate of industrial (urban) areas, as well as of rural and health resort regions. In the course of five years, the local climate of certain

[2] See article by M. K l i m a s z e w s k i. *The Principles of the Geomorphological Survey in Poland* in this volume p. 32.

[3] See article by M. K l i m a s z e w s k i. *The Detailed Hydrographical Map of Poland* in this volume p. 41.

chosen regions should be examined, and a method worked out for rapid climatological surveys in the field.

Combined investigations on geomorphology, hydrography and local climate are to be carried on in the same areas, the most recommended form being collective investigations, organised as complex expeditions. The areas investigated should be decided on in agreement with planning authorities and should be mainly areas intensively invested, or areas insufficiently developed.

In addition to the above, a recommendation has been issued concerning the undertaking of work on so far in Poland underdeveloped branches of physical geography, i. e. biogeography, soil geography and oceanography.

4. THE PHYSICAL GEOGRAPHICAL REGIONS OF POLAND

An attempt was made, in 1946, to divide Poland, in its new frontiers, into physico-geographical units. This division was revised in 1954, since it had been based on the former belt distribution of the geographical regions in Poland, and did not pay sufficient attention to the differences in land relief and vegetation between the various parts of the country. The new attempt was worked out by J. Kondracki 1954 [4]. Some progress was made, but, all the same, further work must be undertaken on the division of Poland into physico-geographical regions, due consideration being given to all the components of the natural environment. Such a division should include areal units of different orders.

5. PHYSICAL GEOGRAPHICAL MONOGRAPHS OF THE VARIOUS REGIONS OF POLAND

The work which is to be launched will concentrate on a complex characteristic of the natural environment, treated as a dialectical whole, and also on a study of the mutual relationships of all its components and the processes therein occurring.

At the same time, an estimation should be undertaken as to the suitability of the natural environment for various branches of national economy (e. g. industry, agriculture, building), and also as to the extent of the transformations in natural environment already affected by economic activity.

In such investigations, attention is particularly needed for the study of small areas, which have been invested in and transformed (very numerous forms of human origin), i. e. industrial towns or settlements. This work elaborated in Poland as a distinct field of investigations within physical geography is called urban physiography.

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In economic geography, the investigations will concern the development and distribution of the different branches of production and services, inter-connected into regional systems (geographical-

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[4] See article by J. Kondracki. *Natural Regions of Poland* in this volume p. 48.

economic regions) based on the geographical (territorial) division of labour. In analysing the distribution of production of various branches of economic life in different regions, it is necessary to take into account: (1) meeting the needs of the people on a national and regional scale; (2) the establishment of conditions and possibilities of a further production increase (socialistic reproduction); (3) the estimation of the proper utilization of geographical environment in the localization of production. Attention should be paid to the utilization of the natural environment so far.

6. LAND UTILIZATION IN POLAND

The preparation of a general land utilization map on a scale of 1:300.000 was begun in 1947. It is based on the 1:100.000 topographical maps produced during the interwar period. The map, to be finished in 1956, shows areas covered with arable land, forests, meadows and grassland, rivers, and settlements.

The need for a detailed map of land utilization has become felt in recent years in planning offices and by regional planning authorities. Monographic studies concerning socialised farming units and intensive suburban economy have also been undertaken. Arable land have been considered from the point of view of rotation types. Social relations, and the agrotechnical level of farming have also been taken into account. In the case of permanent forms of land utilization such as forests, meadows, pastures, the classification into natural or economic types has been taken into consideration. In the course of the next five years, a method is to be worked out for making detailed field surveys on land utilization. The changes in land utilization over certain areas must also be studied [5].

7. THE ECONOMIC-GEOGRAPHICAL REGIONS OF POLAND

The problem of economic regionalisation has for many years interested economic geographers. This problem is at the moment being studied with particular care. since, in addition to satisfying the practical needs, resulting from a planned economy, it is necessary to work out theoretical bases for a regional division of socialised national economy. Economic-geographical regions are treated as being the result of territorial division of labour.

During the Five-Year Plan, the division of the country into economic-geographical regions of the first order should be completed; the principles are to be established for linking them with the administrative divisions and a division into smaller economic-geographical units is to be carried out in the case of certain regions.

8. STUDIES OVER THE CONDITIONS OF DEVELOPMENT OF THE ECONOMIC REGIONS

These studies have for long been closely connected with monographic works. The problem of regional monographs came to the fore again after the Second World War. A number of new studies were started, most

[5] See article by K. Dziewoński: *Detailed Survey of Land Utilization in Poland* in this volume p. 26.

of them dealing with towns and counties (powiats). Attempts have, however, been made to bring to the new elaborations a different conception, the stress being no longer laid on the physical aspect of towns, their horizontal plan, their limits and territorial development; special attention is being given instead to the functions of towns, and the extent of their sphere of influence both closer and more distant [6].

The result has been to transform the character of the work, from that of encyclopaedic monographs into studies on the activisation possibilities of the investigated territories, inherent in natural environment, in labour reserves not fully utilised, in already existing investments, in farming conditions, etc. The work has been undertaken especially on under-developed towns or counties.

At the same time, work has been started in Poland on a reform of the administrative division of the country which provides for the formation of some 500 smaller counties in place of the 270 ones. For the last two years, many monographs of those new counties were worked out. There has been also concentration of work in certain parts of the country. During the 1956—60 Five-Year Plan should be studied in that way all the counties of Białystok province (voivodeship). Basing on these monographs and other studies larger geographic monograph of that province will be undertaken. Further studies should be started on other provinces.

9. DEVELOPMENT AND DISTRIBUTION OF THE DIFFERENT BRANCHES OF PRODUCTION

Investigations on the development and localization of production are needed both as regards Polish territories during the capitalistic period, and as regards People's Poland. These investigations should take into account the links as between each branch of production and the entire economic life, determine its role in the economy of the country or region and study the bases of its further development against the background of analysing the possibilities of the utilization of the natural environment, of labour conditions, and of investment reserves. These elaborations are grouped in four branches of economic geography: geography of agriculture, geography of industry, geography of transport, and geography of population (including settlements geography).

In addition, as regards economic geography, work is required on those branches which have been particularly neglected in Poland, such as economic cartography and regional economic geography of foreign countries, with special reference to those countries which are of the greatest interest to Poland — the Soviet Union, the People's Democracies, and so on.

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In addition, physical and economic geographers face the following common tasks:

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[6] See article by J. Kostrowicki and S. Leszczycki. *Contribution of Geography to the Planning in Poland* in this volume p. 19.

10. HISTORY AND METHODOLOGY OF POLISH GEOGRAPHY

This question was generally underestimated and neglected during the inter-war period. Since World War II, there has been a considerable quickening of work in this sector; Poland's first chair of history of geography was inaugurated at Wrocław in 1945. In the course of preparations for the First Congress of Polish Science, in 1951, considerable stress was laid on work on the history of Polish geography. The achievements of the first ten years of People's Poland have now been summed up [7]. What is required of this study is that it gives an estimation of the achievements of Polish geography from the point of view of Marxist philosophy, and that it brings out its progressive trends.

During the Five-Year Plan, it is visualised that the history of Polish geography during the inter-war period will be worked over, together with the history of economic geography and cartography from their beginnings; special studies are to be devoted to Polish geography in the periods of the Renaissance and the Enlightenment. These studies are to show what methodologic influences Polish geography has been subjected to in its development, what have been the causes of those influences, and what effect such influences exerted on the further development of this science. What is to be required is to present Polish geographic thought against the background of the leading world theories and opinions of any period.

11. PHYSICAL AND ECONOMIC GEOGRAPHY OF POLAND

For some years the lack has been felt of an up-to-date university textbook on the geography of Poland. It was decided, in 1952, to publish a collective compendium based on the present state of geographical knowledge of this country. The work is to comprise five parts: a) general information on Poland; b) physical geography (components of the natural environment); c) physico-geographical regions; d) economic geography (geography of branches of production, geography of population); e) economic-geographical regions.

12. ATLAS OF POLAND

Every country endeavours to represent the facts concerning itself and its national economy in cartographic form in a national atlas. Poland has here a good tradition, for atlases of this type, compiled by E. Romer, were published as early as between 1916 and 1921. During the inter-war period no initiative was undertaken in this direction. Only after the Second World War, in 1947, was work on an *Atlas of Poland* begun. A too frequent variation of the composition of the Editorial Board led to the first three numbers comprising 18 maps on a scale of 1:2.000.000 being issued only in 1953—1955. These concerned chiefly physical geography.

[7] See "Przegląd Geograficzny" (1954), No. 3.

During the next five years, it will be necessary to work out a new concept of the *Atlas of Poland*, to lay out a proper pattern and to begin printing a second edition which will fully correspond to the national atlases of our time.

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Other work to be put in hand includes documentation comprising:

1. Polish geographical names,
2. Polish geographical vocabulary,
3. a bibliography of Polish geography,
4. a critical evaluation of the statistical and cartographic sources for geographical investigations on the capitalist period in Poland,
5. the change in the political-administrative division of Polish territories during the 19th and 20th centuries.

The geographical problems enumerated here show the directions which the development of geography in Poland is expected to follow during the next few years. These tasks must not, of course, be treated inflexibly; the plan will undergo certain modifications as results are obtained, and as the needs of the country come to the fore.

From the Institute of Geography
of the Polish Academy of Sciences

JERZY KONDRACKI, STANISŁAW LESZCZYCKI, BOGODAR WINID

THE POLISH UNIVERSITY SYSTEM OF GEOGRAPHICAL TRAINING

The history of geographical studies in Poland dates back some distance, the first chair of geography having been organised in 1849 at the Jagellonian University, Cracow. Before the First World War, there existed two chairs of geography, one in Cracow, and one in Lwow. Between the two world wars, this number increased to 7; now, there are 23.

Up to 1926, the system of studies in Polish universities was similar to that generally adopted in Central Europe; every professor instructed his students according to his own system, on the basis of his own knowledge, ability and preference. He was able to adapt his method and scope of teaching to the individual capabilities of each student. The students also had complete liberty to choose courses and classes; they could follow the method indicated by the professor, or adhere to ways of their own; this tended to develop their self-reliance and initiative.

This system had many of the features of the Mediaeval method of training apprentices by masters; it gave good results in the case of gifted students, relatively few in number, desirous of pursuing scientific work, but it gave much less satisfactory results in the case of the large groups of not so gifted students — average geographers — with teaching as their goal. The system also had the disadvantage of tending to produce geographers of varying individual standard — the inevitable result of the different degrees of understanding achieved as between the professor — the master — and the student — the apprentice. Thus, anyone employing geographers was never certain as to the knowledge of the graduate who applied for a job, or what work in the particular institution his training best fitted him for. This led to some very unsatisfactory incidents, for, over and above a few scientific posts, there were not many occupations open to geographers. The result was that they accepted various casual posts, or were principally employed as secondary school, or even primary school, teachers. The search for employment was left to the graduate himself, and whether he obtained one or not, largely depended on his luck.

With a view to ending the uncertainty as to what knowledge a geography graduate actually possesed, a new system of studies was introduced in 1926. This defined the scope of studies by making compulsory the passing — in principle, within four years — of 10 predetermined examinations. Students also had to attend courses and classes for at least 15 hours weekly (10 hours weekly during the final-student-year).

There were two groups of examinations. In the first, 8 subjects were compulsory for all students; in the second, entrants might choose 2 out of 4 specialised subjects. The examinations subjects were: 1) geology; 2) meteorology; 3) plant and animal geography; 4) ethnology, ethnography, or anthropology; 5) mathematical geography; 6) general geography; 7) regional geography, with special reference to Poland; 8) philosophy. The specialised examinations were in: A. Cartography: 9) mathematics; 10) cartography; B. Geomorphology: 9) regional geology; 10) geomorphology; C. Climatology or hydrography: 9) geophysics or experimental physics; 10) climatology or hydrography; D. Human geography: 9) history of culture or economic history or economics, or statistics or sociology; 10) human geography, or economic geography.

Although the number of examinations was fixed, the studies did not follow a uniform syllabus, being rather conducted in a different manner in each university centre as well as varying in scope. Moreover, geographical studies tended, as the above list of examinations shows, to be of an encyclopaedic character; relatively little attention was given to strictly geographical subjects, and the range of knowledge acquired by the graduate was not adapted to the possibilities and demands of his occupation. The syllabus of studies for the B. A. did not satisfy various professors, and it was therefore frequently criticised, with the result that in 1939 a new programme was worked out. This was, however, never put into existence because of the outbreak of war.

During the Nazi occupation, the geographical studies were kept going in underground, in Warsaw and Cracow, on a sylabus which showed certain changes and corrections as against that effective since 1926 [1].

After the war, discussions were started in 1945, on the programme of university geographical studies; a variety of projects were submitted to the Ministry of Education. Nevertheless, the 1926 syllabus remained effective until 1949. It was only after planned economy had become somewhat stabilised in Poland, only after the completion of a phase of essential reconstruction and consolidation of the country's social and economic life, that deficiencies in the number of available experts, and also the inadequacy of employment for geographers could be fully assessed. A decision was taken to make good the deficiencies and to ensure full employment for geographers, in accordance with the needs of cultural and economic life.

Planned employment of highly qualified geographers could only be effected given the following conditions: — 1) enrolment for geographical studies to be in conformity with the possibilities of employment; 2) the introduction of uniform syllabuses so exactly laid down and pursued that employing institutions might know what might be expected of a B. A. in geography; 3) studies to cover a fixed period of time, not to be extended,

[1] S. Leszczycki. *On Syllabus of Geographical Studies in Polish Universities.* "Przegląd Geograficzny" (Polish Geographical Review). Vol. XXVI (1954) No. 1.

this being only possible in case of a proper discipline; 4) the State guarantee to all students material basis for subsistence during the study period.

The new programmes were prepared in conformity with these principles, as can be seen from the annual syllabuses worked out on an hour-by-hour basis, and in the detailed curricula of particular subjects. The hour-by-hour syllabus comprised a list of all courses, classes, seminars, discussions, and practical work to be followed for each week of each term. The detailed scheme constituted, so to speak, a complete blueprint of the various courses and classes. Considerable attention was given to the preparation of textbooks and notes, and to the preparation of appropriate translations by the geographers themselves.

As compared with the considerable demands of the country vastly devasted during the war, there was a marked deficiency in numbers of highly qualified geographers, particularly among secondary schoolteachers. As a remedy, the Ministry of Higher Education — which emerged out of the Ministry of Education — introduced, by way of a temporary measure, two-stage studies. After successfully pursuing their studies for three years, and passing all the prescribed examinations, students obtained a diploma, which qualified them for official and secondary school employment. To obtain a degree, the student was required to specialise in one of six branches: — physical geography, geomorphology, climatology, World economic geography, economic geography of Poland, or cartography. This stage of study covered 1½ years. Only about one third of all students — the most capable of those who obtained a diploma — were to be admitted to the degree stage of studies. This stage was intended to prepare students for independent scientific work in the subjects covered by the specialities existing in the various universities. After preparation of an acceptable thesis, the student was granted his magister's (B. A.) degree. This dual system did not meet with the approval of most geographers, because the three-year studies, conducted according to a school system, did not develop the students' initiative, gave them no specialisation, and imparted insufficient knowledge. Hence, two years later, when the principal gaps, especially in the secondary schools had been made good, this dual system was abandoned.

From 1951/52, a uniform four-year course has operated, with a view to raising the level of training, enabling all students to get a more profound grasp of their speciality, and this to obtain their B. A. degree. This four-year period was, after the most urgent needs for geographers had been filled and as a result of the general raising of standards, extended to five years. The uniform five-year course, introduced in 1953/54, is effective to this day and therefore claims the principal attention in the present article.

The five-year syllabus was elaborated by a group of Professors of Geography — experts on the Academic Board under the auspices of the Ministry of Higher Education.

A feature of these studies is their wide, uniform basis, covering 3 years and comprising general subjects — philosophic, economic, foreign

GENERAL SYLLABUS FOR ALL STUDENTS
(a new scheme for 1956/57)

Years	1	2	3	4	5	Total
1. Theory of Socialism	30	—	—	—	—	30
2. Political Economy	30	30	—	—	—	60
3. Philosophy	—	—	90	—	—	90
4. Elements of Pedagogical Sciences	—	—	60	60	—	120
5. Methodics of Geographical Teaching	—	—	—	112	—	112
6. Geology	180	—	—	—	—	180
7. Mathematical Geography	45	—	—	—	—	45
8. Cartography and Topography	150	—	—	—	—	150
9. Statistics	30	—	—	—	—	30
10. Meteorology and Climatology	60	60	—	—	—	120
11 Hydrography and Oceanography	—	75	—	—	—	75
12. Geomorphology	—	120	—	—	—	120
13. Pedology and Soil Geography	—	60	—	—	—	60
14. Biogeography	—	60	—	—	—	60
15. Geography of Agriculture	—	75	—	—	—	75
16. Geography of Industry and Transport	—	—	60	—	—	60
17. Geography of Population and Settlements	—	—	45	—	—	45
18. Physical Geography of Poland	—	—	60	—	—	60
19. Economic Geography of Poland	—	—	60	—	—	60
20. World Regional Geography	—	—	150	—	—	150
21. History of Geographical Discoveries	30	—	—	—	—	30
22. History and Methodology of Geography	—	—	—	—	30	30
23. Proseminar of physical geography	60	—	—	—	—	60
24. Proseminar of economic geography	—	60	—	—	—	60
25. Proseminar of regional geography	—	—	60	—	—	60
26. Geographical Discussions	—	—	—	28	28	56
27. Geographical Seminars (on the special courses)	—	—	—	56	56	112
28. Foreign languages	120	120	—	—	—	240
Total	735	660	585	256 *	114 *	2350

* Without special courses.

languages — compulsory for all university students, subjects auxiliary to geographical studies, pedagogic subjects, and strictly geographical subjects.

The table given above shows number of hours (including courses and classes) envisaged by the plan for each subject.

The average number of compulsory examinations is 5 a year. After these extensive basic studies, uniform for all geographers and taking into account pedagogical needs, there follows specialisation during the next two years. At present, there are in Poland 6 specialised courses in geographical studies: — 1) Physical Geography of Poland; 2) Geomorphology; 3) Climatology or Hydrology; 4) Economic Geography of Poland; 5) World Economic Geography; 6) Cartography. Each specialisation has its own syllabus of courses and exercises, some 500 to 600 hours are allotted during each of these two years for the writing of the magister's thesis.

The following are the detailed programmes of each specialisation:

Physical Geography of Poland: 1) climate of Poland — 30 hrs.; 2) hydrography of Poland, with principles of management of water resources — 30 hrs.; 3) geomorphology of Poland — 30 hrs.; 4) geology of Poland — 30 hrs.; 5) the soils of Poland — 26 hrs.; 6) the biogeography — 26 hrs.; 7) monographic courses — 30 hrs.; 8) optional subjects: — urban physiography, physical planning, nature protection, or methodology of field surveys — 60 hrs.

Geomorphology: 1) petrography — 60 hrs.; 2) regional geology, particularly of Poland — 56 hrs.; 3) geomorphology of Poland — 30 hrs.; 4) selected geomorphological problems — 30 hrs.; 5) monographic courses — 30 hrs.

Climatology or Hydrology: 1) selected problems of synoptic meteorology — 60 hrs.; 2) general climatology (physical foundations) — 52 hrs.; 3) the climate of Poland, with special reference to the agroclimate and bioclimate — 56 hrs.; 4) regional climatology — 60 hrs.; 5) climatological study methods — 84 hrs.; 6) the hydrology of continental waters (only for hydrologists on the place of general and regional climatology) — 112 hrs.; 7) hydrography of Poland with principles of management of water resources — 30 hrs.; 8) monographic courses — 30 hrs.

Economic Geography of Poland: 1) natural bases of Polish economy — 146 hrs.: 2) the economic planning — 26 hrs.; 3) physical planning — 60 hrs.; 4) economic cartography — 60 hrs.; 5) monographic courses — 82 hrs.; 6) economic history of Poland — 30 hrs.

World Economic Geography: 1) selected problems of the physical geography of the world — 41 hrs.; 2) geography of mineral resources — 30 hrs.; 3) etnography — 26 hrs.; 4) selected problems of world economic geography — 41 hrs.; 5) economic cartography — 45 hrs.; 6) monographic courses — 82 hrs.

Cartography: 1) mathematics — 90 hrs.; 2) mathematical cartography — 78 hrs.; 3) geodesy and topography — 39 hrs.; 4) general mapping science — 60 hrs.: 5) map editing — 45 hrs.; 6) applied cartography — 52 hrs.; 7) map reproduction — 45 hrs.; 8) the history of cartography — 30 hrs.; 9) monographic courses — 41 hrs.

Thus, the specialisation syllabuses enable every geography student to specialise in one or other branch of geography; they clearly indicate the stage he is required to have reached on the conclusion of the academic study period; at the same time they make it possible for institutions employing geographers to secure specialists with a known range of knowledge, while at the same time enabling such institutions to make their own suggestions as to what would be useful in the preparation of outlines of studies. This system has resulted in geographers being engaged by numerous institutions other than schools.

A specific feature of the programmes of geographical studies in Poland is the grat stress laid on field work and practice. At the end of each annual study period field work is set for the summer period (from June 21 to July 31). Thus, after the first year of studies, students are practised for 2 weeks in topography and 2 weeks in meteorology, and take part for 1 week in excursions. At the end of the second year, field work is undertaken as follows: — 2 weeks hydrography, 2 weeks geomorphology and 1 week of excursions. At the end of the third year, there is field work in economic geography for 2 weeks, 1 month of pedagogical practice and, moreover, every student must work for 3 weeks in a scientific research institution and take part in a week's excursion. At the end of the fourth year, 6 week's practice is obligatory, in connection with the student's writing of his magister's thesis.

The excursions are so chosen as to allow students to familiarise themselves personally with the principal areas of the country. Both practice and excursions are at the State's expense. At the conclusion of five-years' studies and the practical exercises, and after passing examinations, writing a thesis and defending it before a commission, the student obtains his magister's degree in geography. Obviously, no second subject can be studied simultaneously.

Since the Second World War, geographical studies have widely extended in Polish universities, geographical departments have been founded at all seven universities. On 1st January, 1956, there were 23 chairs in universities, involving 44 independent scientific workers (2 ordinary professors, 22 extraordinary professors, 14 docents and 6 assistant professors), and some 80 auxiliary scientific workers.

The following shows the distribution of geographical specialisation centres:

1. Physical Geography — 6 (Cracow, Lublin, Poznań, Toruń, Warsaw, Wrocław).
2. Geomorphology — 2 (Łódź, Wrocław).
3. Climatology — 2 (Warsaw, Wrocław).
4. Cartography — 2 (Warsaw, Wrocław).
5. Economic Geography of Poland — 1 (Warsaw).
6. World Economic Geography — 1 (Warsaw).

In all — 14 specialised groups.

It is intended, during the next five years, to set up two further groups of specialisation in economic geography in two further centres, 1 or 2 devoted to hydrology (oceanography) and 1 to geography of soils.

Assuming that each specialisation group will turn out annually about 10 B. A.'s, the enrolment for geographic studies in Poland should amount to from 140 to 200 students every year. At the present moment, the total number of students in all years, at all the Polish universities, is about 1,000.

The fact of putting the system of training geographers on a uniform basis enables them to be employed in a considerable number of institutions. As an example, there is given below the list of institutions in which 181 geographers, who completed the B. A. course at Warsaw University between 1946 and 1953, found employment:

Secondary schools,	9	per cent.
Academic schools,	16	,, ,,
Research institutions,	8	,, ,,
Geological service,	13	,, ,,
Hydrological and meteorological service,	10	,, ,,
Planning authorities,	11	,, ,,
Cartographic service,	10	,, ,,
Various economic and administrative offices,	17	,, ,,
Cultural and educational institutions (libraries, editorial offices),	2	,, ,,
Data not available,	4	,, ,,
Total	100	per cent.

This list shows that, during the first ten years of People's Poland, geographers found extra-mural employment, and therefore the problem of giving a pedagogic twist to studies, and adapting them to the requirements of education, has been practically non-existent. A somewhat larger proportion of geographers has been directed into teaching channels from the provincial universities.

During the period there have been set up in the Teachers' Colleges, 3 Geographical Departments, which have graduated, after a three-year course, more or less similar to the university course, some 100 geographers as teachers.

Intensive training methods during the last ten years have made it possible to satisfy the most acute demands for geographers. Those demands are today much less sharply felt. A survey made in 1955 has made possible an estimate of the employment demand for geographers during the coming five years, i. e. up to 1960. The figure, in addition to those needed by the schools, is 65 geographers annually as follows: — Academic schools and research institutes — 20 geographers annually; Geologic service — 3; Hydrologic-meteorological service — 8; Economic and physical planning offices — 20; Cartographic service — 5; Various economic and administrative offices — 5; Cultural and educational institutions (libraries, editorial offices, etc.) — 4.

Thus, the situation has undergone a complete change; the universities themselves are, according to the plan, to graduate about 200 B. A.'s in geography; of these, one third at most will find employment in professions other than teaching. Hence the question of giving studies a pedagogical twist has again come up to the fore, and pedagogical subjects have been made obligatory for all geography students. The liquidation of or restriction on training geographers in the Teachers' Colleges has become a matter of moment. This emerges from planned economy which requires that the enrolment of geographers should be determined by the society needs and by employment possibilities.

With the training plan is also connected the general didactic specialisation of the various university geographical centres. As a rule, such specialisation is linked with research tendencies in these centres, for in addition to the two great geographical centres — Warsaw with 5 specialisations and Wrocław with 4 — the remaining centres have only a single specialisation each, and that is principally in physical geography (Cracow, Lublin, Poznań, Toruń) or geomorphology (Łódź).

University studies are free, and about 80 per cent of the students are maintained at State expense, receiving scholarships and living in student's hostels.

Scientific workers are trained on special post-graduate courses. These begin after a student has obtained his magister's degree, and generally he has done two years of professional work. During this period the graduate must give evidence of special ability and of a bent for scientific work. In Poland post-graduate courses are of three years duration, in the course of which an aspirant to scientific work, endeavouring to obtain his degree as "candidate in geographical sciences" must pass examinations in two foreign languages, a philosophy, a basic subject, which may be physical geography, economic geography or cartography, and a specialised subject, which may be either geomorphology, climatology, soil geography, industrial geography, agricultural geography or another branch of geography.

The aspirant is required to write a scientific thesis, in which he must show not only mastery of the technique and methodology of scientific work, but must also reach original conclusions constituting in some sense a contribution to the science of geography.

The State bears the cost of an aspirant's studies. He receives a scholarship, accommodation, and other facilities. At present there are some 20 such post-graduate aspirants in geography studying in Poland.

For those who work professionally in other than educational institutions or research institutes, a four-year correspondence course has been introduced. During such a period, the institution where the aspirant is employed is required to make available to him a number of facilities concerning his studies.

Independently of organised post-graduate courses, every geography B. A. may obtain a degree of candidate in geographical sciences by passing the examinations referred to above and preparing an appropriate thesis.

The highest scientific degree in Poland is that of Doctor in Geographical Sciences. While completing his thesis, for a doctorate, a graduate may also, for a period of two years, receive a scholarship and accommodation at State expense.

Graduates may prepare for their degree of candidate in geographical sciences and Doctor in Geographical Sciences at universities and in the Institute of Geography of the Polish Academy of Sciences.

Needless to say, that our system also has its shortcomings. Students tend to be overburdened, too little consideration is given to individuality, and there is not sufficient encouragement to independent work. Nevertheless, the system has the following important advantages:

1) an extensive, uniform basis for all students;

2) specialisation, adequately intensified and suited to the requirements of the institutions which employ geographers; hence an extension of the variety of such institutions;

3) an accurate definition of the scope and essence of what a B. A. in Geography should be capable of;

4) punctual conclusion of studies at prescribed times, the product of discipline (compulsory attendance at lectures and exercises, passing of examinations, etc.);

5) adaptation of enrolment to the possibilities of employment of geographers;

6) specialisation of the different university geographical centres;

7) the possible employment of all geographers in teaching, as a result of the compulsory university pedagogical studies;

8) the fact that the State covers the cost of studies, in particular special studies of scientific workers, through the organisation of aspirants' and doctors' courses.

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JERZY KOSTROWICKI, STANISŁAW LESZCZYCKI

CONTRIBUTION OF GEOGRAPHY TO THE PLANNING IN POLAND

The linking of geography and planning in Poland took place for the first time during the years between the wars, when a number of local government regional planning offices were set up. Individual geographers assisted with the work of these offices. In the conditions prevailing at that time, physical planning was an outcrop of progressive thinking. Its advocates endeavoured to counteract certain disproportions, particularly striking in the towns, in the administration and in provision made for the needs of the population. Advocates of regional planning opposed the socially unjustified differences between the neighbourhoods inhabited by the well-to-do bourgeoisie and those alloted to the unpecunious proletariat — in short, the subordination of the needs of the people to the interests of privileged individuals. Planning was at that time, nevertheless, idealistic in character. Plans for urban and regional development were made without reference to the possibility of being realised; reliance was placed on the goodwill of those with whom rested the last word — the rich capitalists.

No wonder, therefore, that regional planning had not, at the time, anything much to show for its efforts. It was, nevertheless, a school in which town planners and geographers learned to link their work with questions of importance to economy of the country. They also learnt something of methods of complex approach to economic problems. Such work resulted in a number of studies, which were at the time of considerable methodological importance. These studies also included geographical studies [1].

All research work was interrupted in Poland during World War II, laboratories were destroyed, the country and its people suffered unprecedented losses at the hands of the Nazis. Many town planners and geographers were killed.

The years immediately following the war were a period of intense reconstruction, in which scientists, including geographers, played a full role.

[1] Among the geographers who co-operated with regional planners were J. Smoleński, S. Leszczycki, B. Zaborski, F. Uhorczak, and others. The most complete example of geographical studies conducted in connection with the needs of planning is the monograph on part of the Carpathian Mountains *Region Podhala — podstawy geograficzne planu regionalnego (Les bases géographiques du plan régional du Podhale)* by S. Leszczycki, Prace Inst. Geogr. U. J. No 20, Kraków 1938.

During that period, there existed in Poland two planning offices: the Central Planning Office (CUP) and the Chief Office of Physical Planning (GUPP)[2], dealing respectively with economic planning and physical planning. These offices had branches in every voivodeship (province). The network of physical planning offices was particularly well developed, employing partly the staff of the former regional planning offices. Geographers took an active part in physical planning, some 30 geographers being employed in the planning offices, some of them took there the leading position[3]. Since the academic schools, then only beginning to be rebuilt, and in the course of reconstructing their scientific workshops, naturally had to direct the main effort towards teaching, the conditions for scientific work were better at the planning offices.

In result there were accomplished as part of the work of the Chief Office of Physical Planning of a considerable number of geographical studies covering both the whole country and certain particular regions[4]. Numerous studies were also undertaken on order of the GUPP by geographers working at universities. All these studies were made use of later in drafting the Six-Year Plan.

All the same, the work of the planning offices left much to be desired in many respects. As regards physical planning, it did not care much for the realisation of its plans. The plans came to look something very like geographically distributed collections of wishes. Nobody gave much thought either to the how or the when of giving effect to them.

In 1949, Polish planning was reorganised. Within the single agency of the State Economic Planning Commission (PKPG) were concentrated both economic and physical planning. At the same time, important changes in planning methods were introduced.

Progress in the organisation of science had meantime intensified scientific work in the academic schools, a fact which led to the transfer of some geographers from the planning offices back to the academic schools, and to a consequent shift to the universities of a great part of the research work carried out for the needs of planning.

It was only at the beginning of this period, between 1949 and 1951, that the planning offices engaged in any work of a scientific character — principally on the localisation of industry and settlement[5]. Thereafter, the planning offices occupied themselves more and more with organisation and co-ordination. All scientific work passed into the orbit of the

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[2] K. Dziewoński. *Studia geograficzne dla celów planowania w latach 1945—1954 (Geographic Studies for Planning Purposes between 1945 and 1954).* 'Przegląd Geograficzny" (Polish Geographical Review), Vol. 26 (1954), No. 3, pp. 107—122.

[3] The Vicepresident of the Chief Physical Planning Office was the geographer J. Zaremba. The following geographers directed the provincial Physical Planning Offices — S. Leszczycki, A. Wrzosek, R. Galon, and F. Uhorczak.

[4] Among the publications attention must be drawn to two parts of the Atlas on the Study of the National Plan (Part I, 1947; Part II, 1948), containing a number of cartographic studies on the physical and economic geography of Poland on 79 maps; and the Atlas of the Recovered Territories, Second Edition (1947) containing 45 maps concerning questions arising in the Recovered Territories.

[5] J. Zaremba, K. Dziewoński, B. Malisz, J. Kostrowicki.

academic schools and research institutes. The role of co-ordinator of geographical research was first played by the Polish Geographic Society, and later, from 1953 — by the Polish Academy of Sciences Geographical Institute.

Gradually, the co-operation between geography and planning extended and underwent a change in character, developing mainly in the following directions:

1. On the initiative of the PKPG (State Economic Planning Commission), specialised studies on economic geography of Poland were started at Warsaw University, to train such geographers as were needed in planning offices. On conclusion of their studies, these geographers were employed by the PKPG or its regional and county branches, where they were engaged mainly in matters connected with localisation, physical planning and, recently, also perspective (long-term) planning. This special university course is granting from 15 to 25 magisters' degrees annually to young geographers planners.

2. Not only the provincial commissions of economic planning, but also those studios which are entrusted with the preparation of regional plans of territories requiring spatial reconstruction, or co-ordination of investments, were from 1949 brought under the PKPG. In 1954, they were placed under the Office of Regional Planning instituted at the PKPG. A considerable number of geographers are now employed in their studios, being responsible, above all, for the analysis of natural environment conditions in relation to the possibilities of using them for the development of respective regions. Such geographers are also studying demographic conditions, localisation of production, and so on.

In addition to this direct participation of geographers in work on particular plans, the Geographic Institute of the Academy and the University Departments of Geography are constantly conducting various studies and scientific elaborations [6]. Physical geographers are needed to characterise the elements and the natural environment as a complex, to appraise it economically and to specify the full possibilities of using it, while ensuring that the conditions of the natural environment not be deteriorated by the economic activities of mankind. Economic geographers are engaged in examining the distribution and size of labour reserves and the distribution of production; they compare the extent of industrial and agricultural production of every region with the requirements of its inhabitants. On the basis of their own research, and those of physical geographers, they study the possibilities and trends of economic development

[6] Thus, in 1952 and 1953, detailed geomorphologic and hydrographic maps on the Dunajec river valley were prepared for the regional planning authorities, under the direction of M. Klimaszewski. Similar work was done by the same group on the Upper San river valley. For the requirements of regional planning in the central Vistula valley, this kind of work was carried out under the direction of J. Kondracki and F. Uhorczak, and for the Old-Polish Industrial Region — under the direction of J. Dylik. The Brda valley had its detailed map of the nautral environment prepared under the direction of R. Galon. Settlement and population were studied, for the needs of regional planning in the Częstochowa area, by A. Wrzosek. See K. Dziewoński. *Studia geograficzne do planu regionalnego (Geographic Studies for Regional Planning)*, "Przegląd Geograficzny" (Polish Geographical Review) vol. 26 (1954), No. 4, pp. 3—11.

of a given region, especially from the point of view of the distribution of productive forces and of its links with the natural environment.

In recent years, geographers have taken an active part in studying the area of the Upper Silesian Industrial Region, the development plan for which has received governmental approval. The official nature of the plan later caused scientific research work on this region to be concentrated under the auspices of the Polish Academy of Sciences. The aim of these studies is to supply a scientific foundation for specifying a number of problems introduced in a general manner into the regional plan, and then for realising the plan. Within limits of these studies, geographers occupied themselves, first and foremost, with the geomorphology, hydrography, and climate of this region, which have to a marked degree been changed by human activities. This region suffers from serious difficulties in obtaining an adequate water supply, and moreover its local climate has been changed; both these factors result from the operation of numerous concentrated there mining and industrial establishments [7].

3. To assist the preparing, in Poland, of a number of town plans, research on the natural environment of such towns has been found necessary. As the number of town development plans has increased, so has the need for research of this kind. It was found necessary to create in 1949 a special institution — under the name of "Geoprojekt" for the investigation of natural conditions of town development.

The subject matter of investigations over the natural environment of towns (chiefly the form of the bedding, land relief, watering and climate) was in time distinguished under the name of Urban Physiography [8].

4. From the earliest days of planning in Poland, geographers undertook various studies on behalf of provincial planning commissions. Such studies dealt with the elements of the natural environment of the regions, with demography and settlement, or with various other problems. It was around 1950 that there appeared, with a view to finding, determining, and investigating the possibilities of utilising all kinds of existing resources, chiefly in economically underdeveloped areas, a new field of study.

The territory of Poland is characterised by a considerable disproportion in the economic development of the different regions. Alongside regions with a high concentration of industry and population (with the usual drawbacks known to all conurbations throughout the world) are found on the one hand areas with a balanced economic structure and on the other areas economically retarded, insufficiently industrialised, where agriculture languishes, the communication network is weak, the towns have been insufficiently invested, and cultural and social amenities poorly

[7] The work is being done mainly by the geomorphologic and hydrographic section of the Academy's Geographic Institute under the direction of M. Klimaszewski, and by the climatologic section of the Academy's Geographic Institute, under the direction of J. Paszyński.

[8] See: "Przegląd Geograficzny" (Polish Geographical Review) vol. 27 (1955), No. 3—4.

developed. Of such tend to be in the first place, the eastern and north-eastern parts of the country and certain areas in the central part [9].

Planned economy in Poland has set out to liquidate disproportions in the economic development of the different parts of the country. During the Six-Year Plan, large industry was established in many of these areas, and this infused life into their development. It is not possible, however, for obvious economic reasons, to introduce large industry into all the counties, where it is desired to boost economic activity. Thus, economic activisation should be based mainly on local reserves and possibilities, consisting either in not utilised resources of the natural environment (mineral raw materials, good soils, water power, favourable climatic conditions) or in dormant local labour surpluses skilled or unskilled, as well as building, communication and other investments.

Work began in 1949—1951 on the smaller towns, where the situation had become particularly difficult. Poland has a comparatively dense network of small market towns, their origins back to feudalism. Originally, their basic function was to act as a clearing house between town and country; this function became abnormally developed as a result of which farmers sold their products cheaply, while the inhabitants of large town and industrial centres had to buy them dear. With the concentration of production, many of these towns began to decline by the end of the 19th and the beginning of the 20th centuries. After the Second World War, many social reforms were carried out; with them came the socialisation of trade, resulting in a reduction to reasonable proportions the intermediation between town and country. This resulted in the loss of a considerable part of their town-founding functions and shift of population from small towns to larger ones and to industrial centres [10].

It became an urgent necessity to find new bases of subsistence for these towns, bases founded on new functions — chiefly productive. Geographers began appropriate investigations, which resulted in the elaboration of several score of small town monographs, compiled from the point of view of finding their local subsistence bases [11].

It soon became clear, however, that in order to find a base for the development of a town, an analysis is necessary of natural conditions, as well as one of the economy of the whole of its hinterland. This analysis must be not less detailed than that of the town itself; thus a town monograph expands into a monograph of a small region. Since, with a view to reducing the areas of administrative units and adapting their limits to existing economic units, a reform of the administrative division

[9] B. Malisz, J. Kostrowicki. *Aktywizacja obszarów niedostatecznie zagospodarowanych. (The Enlivenment of Underdeveloped Territories in Poland from 1949 to 1955).* Warszawa. 1952, p. 127.

[10] J. Kostrowicki. *Problematyka małych miast w Polsce w związku z badaniem nad warunkami ich aktywizacji. (Small towns in Poland and their problems),* "Przegląd Geograficzny" (Polish Geographical Review) vol. 25 (1953), No. 4. pp. 12—52.

[11] This type of work was, by a variety of methods. carried out in the beginning principally by the geographical centres at the Universities of Warsaw, Toruń, Łódź and Poznań. A special conference in 1953 descussed methods to achieve some degree of co-ordination. "Przegląd Geograficzny" (Polish Geographical Review) vol. 25 (1954), No. 4.

of the country was undertaken at the same time, the hinterland of small towns now began to correspond virtually to the total areas of the new counties. Hence, the later monographs deal no longer with small towns, as such, but with entire new administrative units (counties), examining and analysing them not only from the point of view of the development of the county-town, but from that of the entire district. During 1954 and 1955, this type of work was, at the Academy's Geographic Institute and at Warsaw University, concentrated on the area of the voivodeship of Białystok — economically the most backward part of Poland. In the course of three years, monographs on all counties of that province were compiled. A number of papers on natural conditions and the economy of the entire province were undertaken, also with a view to finding bases for its development. Till now, 27 scientific papers were prepared concerning that province. Altogether some 50 studies are planned; they will contain material enabling a decision to be made on the direction to be taken by the economic development of this region. All these studies will referred to the provincial planning authorities as well they will serve as a basis for elaboration of scientific monograph on the Białystok Voivodeship.

Concentration of work on a single area has accelerated the achievement of results and revealed number of methodological advantages. An organised staff of workers was created operating together on their own lines and within their own capacities towards a common goal. After completing the work on Białystok voivodeship they will proceed to another province, where experience already gained will stand them in good stead.

5. The Academy's Geographic Institute, founded in 1953, has a staff of 80 scientific workers. It receives considerable grants from the State for scientific research work, since, alongside of the theoretical and methodological aims, the Institute has accepted the responsibility of linking science as closely as possible with practice. To this end, close contacts are being maintained with the State Economic Planning Commission. A number of studies of national importance, have been undertaken on a co-operative bases. Here are included the elaboration of detailed 1:25,000 geomorphologic, hydrographic, local climate, and land utilization maps; investigations over the enlivening of areas retarded in development; and work on the division of Poland into physico-geographical and economico-geographical regions. Such problems, with many others, provide the hard care of the Institute's research work [12]. Investigations are carried out in consultation with the State Economic Planning Commission, both as regards terms and the areas studied, in order that results may be available before work is commenced on the preparation of regional plans of larger investment projects.

6. In 1955 a separate Department of Perspective Planning was organised in the State Economic Planning Commission. This was necessitated by its being found impossible to prepare properly the plans

[12] S. Leszczycki. *Ogólnopolski plan badań geograficznych (Der polnische Plan geographischer Forschungen).* "Przegląd Geograficzny" (Polish Geographical Review) vol. 27 (1955), No. 1 and the paper by the same author in this volume p. 3.

for the next five-year period without outlining further prospects of economic development of the country and of its various parts. It is clear that perspective economic development plans require a more intense participation with science in the preparation of the bases for such plans. Thus, the Polish Academy of Sciences has instituted under the auspicies of its Board, a "Committee for the Development and Distribution of Productive Forces". The work of this committee is twofold: on the one hand, it deals with the scientific bases of perspective plans for the development of the principal branches of national economy [13], and on the other — with physical plans for each region [14]. Number of geographers take part in that work.

I will clear that geographers are, in Poland, trying to link their work with the needs of national economy, and that to this end, they have succeeded in working out certain forms of organisation. They have practical responsibilities; at the same time they are intensifying the methods and theoretical bases of geography — an achievement which may have a decisive effect on the further development of geography in Poland.

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[13] A plan of this kind was, over a period of three years, prepared by the Committee of Water Economy; it was submitted in January 1955 at a four-day conference on this subject. A group of geographers was also active within this Committee.

[14] For two years this type of work has been carried on in the Polish Academy of Sciences in the Committee for the Upper Silesian Industrial Region, the task of which is the co-ordination of scientific research in this area. The Committee is under the chairmanship of geographer, Professor S. Leszczycki, with whom numerous other geographers are also collaborating.

From the Institute of Geography
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KAZIMIERZ DZIEWOŃSKI

DETAILED SURVEY OF LAND UTILIZATION IN POLAND *

The general importance of land utilization survey is twofold: scientific — for the development of geography and practical — for the planning of national economy, in particular for the planning of agricultural and forest production.

Its scientific importance derives from two basic facts:

a) that economic geography as one of social sciences is concerned with the study of geographical location of production and with conditions and specific character of its development in different countries and regions;

b) that economic geography similarly to other geographical sciences has to begin with study of some concrete material phenomena.

The use of land is just such concrete material phenomenon in which the whole actual process of production is directly reflected in a synthetic form closely connected with geographical environment. Its better understanding, more detailed study is therefore essential for further development of this branch of geography.

At the same time the use by geographers of the concept of "cultural landscape" involves certain danger of strictly formal, or even limited to the visual, definition of direct object of our research. By substitution of land use in place of cultural landscape it is possible to avoid this danger and to connect the direct material object of our research with the way in which a man, an human society exploits for its further development the geographical environment i. e. the surrounding nature.

The practical importance of land utilization survey lies in the detailed information it gives about forms and localization of production which in analysis leads to a better appreciation of rationality or irrationality of the present use and of possibilities of its improvement. It should be stressed that results of such an analysis may be fully exploited only in the planned economy, on basis of the social ownership of means and tools of production.

Such a survey should be obviously very extensive and detailed, it should include all important elements and decisive factors of land utilization, classified in relation to basic economic tasks, especially the productive ones.

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* This paper was read and discussed at the International Geography Seminar in Aligarh (India), January 10th, 1956, and is corrected and developed in the result of then expressed opinions.

All work done so far in Poland on the subject of land utilization was based on materials collated for other purposes. They are topographic and cadastral maps, statistics and lately aerial photographs. In result of great changes in land utilization introduced by the 2-nd World War, great processes of resettlement of population and last but not least by social and economic revolution most of these sources are out-dated. At the same time they contain only a very limited information on the state of land utilization. On their basis we may divide all the land only in the principal types of use. These are arable land, meadows and pastures, forests, orchards and gardens, settlement or built-up areas and waste land. Such work was lately executed in Poland under the direction of prof. F. U h o r c z a k from the Lublin University. On basis of the topographic maps in scale 1 : 100.000 prepared in the years 1930—1938, general maps of different land uses in scale 1:500.000 and 1:1.000.000 were obtained. Those maps give an excellent, precise and illuminative picture of land utilization but at the same time it is obvious that they are insufficient and unsatisfactory for more detailed research. Aerial photographs are also inadequate; the information they supply is visual and certain important from the economic point of view data are completely missing.

For these reasons work was lately started on the preparation of detailed survey of land utilization based on field work. All the existing materials are naturally used to diminish and to shorten the whole scope of the work to be done. In some cases the field work may even be limited to checking materials obtained from various, mainly official sources but all effort is concentrated on giving an adequate, detailed picture of land utilization.

First stage in preparation of such a survey was obviously the general concept of the map. After two seasons of field work we are confident that this concept is sufficiently developed and defined to start work on a wider scale and to present it for discussion on an international basis.

In our work we try to learn from experience of other countries. The admirable work done in Great Britain under the direction of L. D u d l e y-S t a m p was to us an inspiration and an example. On other hand we do go farther than the British geographers.

What is important in study of land utilization is the way man uses (and misuses) the land. If so, the connection between the economic unit producing on land, its forms, types of farming or forestry and the use of land and of geographical environment should be clearly established and studied.

These problems were in the British survey partly by-passed and — or partly oversimplified. Social relations as reflected in the land ownership and in the size and structure of productive units (country estates, farms and peasants holdings) were only in few counties studied and then in a very unsatisfactory manner. In the very interesting Japanese survey the scope was wider — the difference in cropping of various paddy fields was noted — still connections between the use of land and its ownership were omitted.

We are greatly impressed by the monographs of state and cooperative farms (sowchozes and kolchozes) prepared by the Russian geographers and although we strain after study of wider areas we believe that these monographs represent important progress in the research into land utilization, which should be connected with more general work undertaken in other countries especially on the world scale by the International Geographical Union.

The difficulty lies in the fact that there, where the peasant small holdings dominate in the agricultural production the basic productive unit is so small that it cannot be represented cartographically except on maps in very large scales, which fact inevitably limits very much the size of studied area. To by-pass this difficulty we introduced the study of arable land by rural communities (parishes) divided subsequently in clearly defined fields in which the dominating type or types of farming are marked. The bigger units e. g. the State and cooperative farms are studied and represented individually. This is important as in our country we live in period of transition from individual to social forms of agricultural production and the socialist farms are leading and progressive element in both social and economic development. We hope and indeed are certain that eventually, practically all productive units will unite in cooperative, collective farming. This will generally simplify the study of land utilization.

The principal types of land use are subdivided into classes corresponding to different forms of farming, of forestry, of settlement.

For arable land it was necessary to take into account in its subdivision both the dominating specialization in crops and the type of the rotation cycle. These two characteristics combined together give a fairly exact and full picture of actual uses of arable land prevailing at present in Poland. Peasants, very conservative or even antiquated in their agrotechnique usually work on the basis of the three or four year rotation cycles. In some eastern districts three year open field system (with fallow) is still surviving. On other side state and cooperative farms, often just beginning their career, have a pronounced tendency for new experiments. The six or even seven years rotation is common but there are cases of ten year cycle with grass dominating in crops (Williams' system of rotation) and sometimes the whole cycle has to be classified as irregular.

Generally speaking the whole production is concentrated on corn crops but slowly both regional and local specialization is developing.

For meadows and pastures only three classes are accepted. These are connected mainly with water conditions in soil (dry grassland, alluvial meadows and marsh and fen meadows). The difference between meadows and pastures (rough grazing) is in quality of grass and hay obtained in result of cultivation methods. This small number (six in all) of classes is in sharp difference with large number used in British survey. This is evidently connected with small area of land, mostly marginal, left in Poland for meadows and pastures, result of agricultural overpopulation.

An additional problem is created by necessity of collecting exact information about destitute or abandoned drainage, result of war devastations.

On other hand subdivision of forests and woodland is more extensive than in England, due to the large area (about one fourth of the whole country) involved and greater importance which forestry has in national economy. Three basic types of forests (coniferous, mixed and deciduous) serve as basis for classification. These are further subdivided in relation to soil and water conditions (dry, fresh and peatbog coniferous forests; different mixed forests dry and marshy deciduous forests) and predominating species of trees (pine, spruce, fir and larch; oaks, hornbeam and beech, ash alder and others). But besides those classes at least partly connected with native woodland there exist large areas of monocultures of pine or spruce. These are to be converted into classes better adapted to geographical environment because today they are endangered by mass invasions of different insects and pests. Obviously information about their localization and condition is then of some importance.

But classification of forests on basis of ecological characteristics is not sufficient from economic point of view. Age of trees (maturity for felling) and density in case of complete felling system and average yield in case of selective felling have to be noted. For state forests (about 85% of all forests) already possessing their cadaster and management plans the field work is limited to corrections and adaptation of official data — with private forests (practically all belonging to peasants) problem is much more difficult and demands more experienced field observers.

In certain war devasted and depopulated parts of the country an additional problem arises for surveying. This is the invasion of idle pastures, meadows and arable land by forest. From naturalist's point of view the process is extremely interesting, from economic one it is infortunate as such forests, in contrast to properly afforested areas, will be very irregular and sparse.

The built-up areas or otherwise occupied by settlements are subdivided into rural (houses and other farm buildings), suburban (detached, usually one-family houses with vegetable gardens), urban (multi-family, storeyed buildings), and central urban area (mixed use of buildings — mainly residential, commercial or industrial).

The subdivision of land of a concrete town into suburban, urban, and central urban is usually executed on basis of more detailed surveys prepared in connection with town planning development schemes. The system of classification of urban land as used by town planners is extremely developed and precise, and for use in land utilizations surveys has to be generalized in few above-mentioned types.

Waters are not at present further subdivided but a classification of their uses is being prepared and during this season will be tested in field work.

An important problem of land utilization survey lies in the inventory of unproductive (waste) land. Its extent and classes vary from one part of the country to another. In agricultural districts it is divided into idle arable land or meadows and pastures which should be brought back into production or as in case of fallows intensified by use of proper agrotechnique and other land which should be afforested. In industrial regions it is much more complicated as the productive value of land is usually destroyed and its rehabilitation involves at least serious studies, and is often very expensive. Some special studies of waste land in Upper Silesian Coal Basin and Industrial District was lately undertaken by Polish Academy of

Sciences. They include extremely detailed inventory of all unproductive land.

The actual survey work is done in several stages. These are: preparatory work including collection and reproduction of existing maps and statistics; field work during which all materials are connected with the concrete fields or other areas, checked, and then the whole land, piece by piece, noted and described on special standarized cards and finally the analysis of collected data, working out of proper maps and writing of final reports.

The final cartographic representation of collected data consists of preparation of:

1. Basic maps in scale 1 : 25.000 giving a general picture of land use. Their general concept may be seen from the enclosed samples. The same samples give an idea of the accepted classifications;

2. Secondary maps in the same scale as basic maps giving more detailed, picture of additional problems within the principal types of land utilization e.g. for arable land, meadows and pastures, forests, orchards and vegetable market gardens, settlements, waters and unproductive (waste) land. The concept of those maps is ready although details are still under discussion;

Additional informations included in these maps concern:

a) for arable land — average annual yield from one hectare *, special cultures and crops (such for instance as: sugar beets, maise, tobacco), areas of special agricultural problems or difficulties (for instance areas invaded by Colorado beetle) and so on;

b) for meadows and pastures — average annual yield of hay, areas of special agricultural problems or difficulties and others;

c) for forests — average annual yield of wood (in cubic m. per ha) or average accretion of wood from one hectare, special areas (such as mushroom or forest berries productive areas, areas infested by various pests noxious for forest, areas of special interest for science, nature reserves and others) and so on;

d) for unproductive (waste) land — proposals for bringing various areas back in use, possibilities of its reconditioning, and so on.

3. Statistic maps in scale 1 : 100.000 giving a cartographic analysis of collected statistics;

4. Qualification maps in the same scale as basic maps (1 : 25.000)) which are to give a cartographic presentation of connection between use of land and geographical environment. Such a map should show whether the present use of land is enhanced or impeded by the geographical environment, and whether it may be intensified and by what means. At the same time this map should indicate whether geographical environment is in result of its present use deteriorating or improving.

The qualification map will obviously be the final synthesis of land utilization survey.

*) In establishing average annual yield special difficulty arises in finding a common denominator for different crops. Among various, presently studied solutions are: average value of crops per annum, established on basis of constant prices, average weight of dry matter per annum, average caloric value of crops per annum etc.

For preparation of qualification maps, maps of different elements of geographical environment or better the complex maps of such environment seem to be necessary. In Poland, detailed geomorphological and hydrographic maps are at present prepared by geographers and proposals for the map of local climates are under discussion. In few cases (mainly for river flood terraces and for nature reserves) plant communities maps were also executed. Detailed geological maps and soil maps are worked out by special bodies (offices, institutes, and scientific societies). Generally speaking all these different types of maps are uncoordinated. Maps are being prepared for different parts of the country and their contents often are based on divergent concepts and collected by completely different methods.

The preparation of the qualification maps is farther complicated by the fact that in the above mentioned physico-geographical maps the most important for land utilization problems are usually omitted or only indirectly indicated. Complex and dynamic map of geographical environment is obviously necessary, showing the decisive formative factors.

In these conditions an effort is made to prepare qualification maps independently at least for time being from the other physico-geographical maps and based solely on the field observations. However elaboration of such maps creates some difficulties and for this reason we have so far no definite concept of this map. We hope to work it out during coming surveying season and to present it for discussion by the end of the present year.

The whole work on detailed land utilization survey was started in 1954. So far we have achieved an almost fully developed concept of the work to be done. By next year we should be able to present a monograph of land use in one of agricultural districts (powiats) in northern Poland with complete sets of all proposed maps. Work on two or three other powiats should be at the same time well advanced. Then the moment will come for wider discussion of the value of proposed methods and obtained results, and way for more ambitious programme of work shall be open.

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MIECZYSŁAW KLIMASZEWSKI

THE PRINCIPLES OF THE GEOMORPHOLOGICAL SURVEY OF POLAND

A detailed geomorphological survey of Poland based on a detailed geomorphological map has been since 1950 the principal task of Polish physical geography. This work has been done in all universities by the departments of Physical Geography, and since 1954 by the Geographical Institute of the Polish Academy of Sciences. From 1950 to 1955, an area of 50.000 sq. km. was mapped. About 500 people (University lecturers, candidates for higher degrees, graduates, and senior students under the direction of professors) have so far taken part in this work. Two conferences in Cracow *(10, 11)* were devoted to the Geomorphological Map of Poland; at these reports were made on the execution of investigations in the particular centres, and there was discussion of results and methods. Problems of method were also discussed at the meetings of the Geomorphological Map Committee *(8, 12, 14)*. Number 3 of Volume XXV (1953) of "Polish Geographical Review" ("Przegląd Geograficzny") was devoted to the problematics of this map.

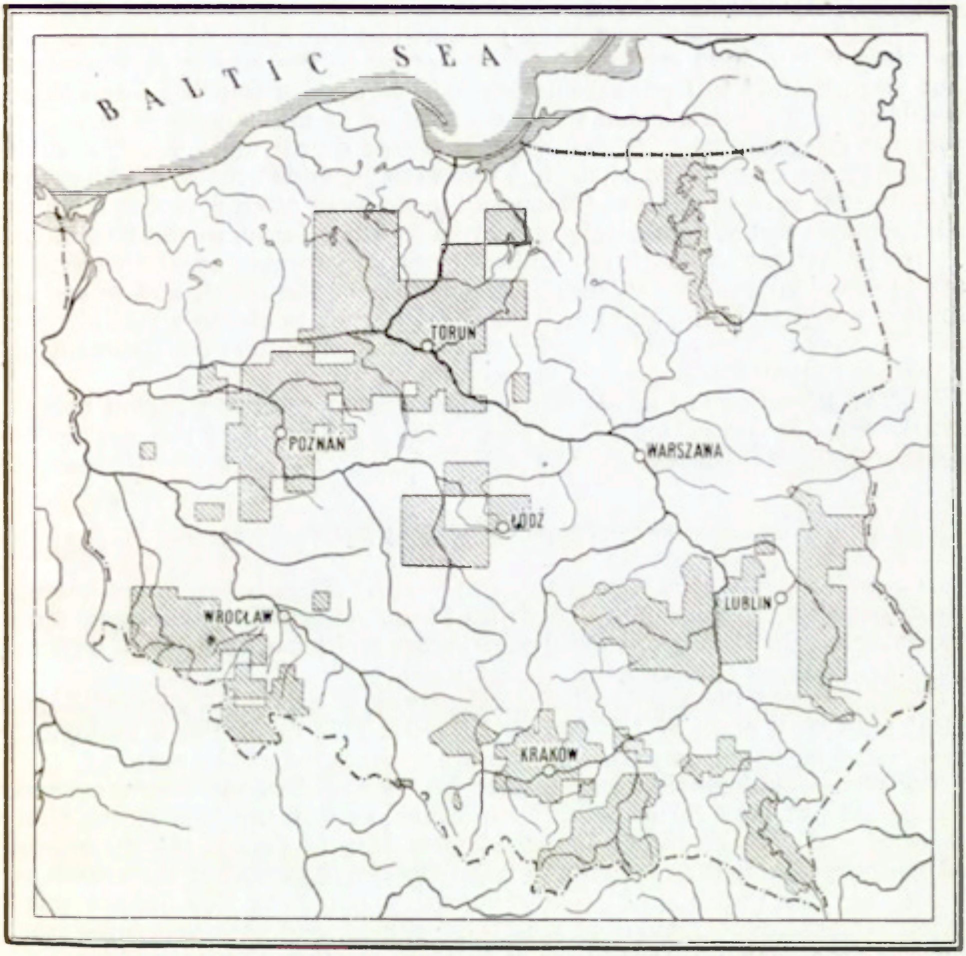
Since 1954, the sections of Geomorphology and Hydrography of the Geographical Institute of the Polish Academy of Sciences in Cracow (Head, M. Klimaszewski) and Toruń (Head, R. Galon) have been responsible for the coordination of investigations, planning, working out methods of research, instruction, verification, evaluation, and arrangement of the whole material collected by Centres. The section in Cracow is responsible for Southern Poland, and that in Toruń for Northern Poland.

At the beginning there was a free choice of terrain, but since 1952, this has been coordinated with the State Committee of Economic Planning because it has proved that the Geomorphological Map is not only of scientific and theoretical but also of practical value, and that it is of use in regional planning. In agreement with planning authorities investigations have been carried out in the river basins of the Dunajec, the Kamienna, the Brda, the Central Vistula, the Upper San, the regions of Kujawy. the Wieprz-Krzna Canal, the Upper Silesian Industrial District and the foothills of the Tatras.

The distribution of areas investigated and mapped by the particular centres is shown in the accompanying map.

THE PROBLEM OF THE SURVEY

The conception of the geomorphological survey of which the outcome is to be a Geomorphological Map of Poland arose out of the endeavour to gain a more accurate knowledge of the relief as one of the elements of the natural environment, from the desire to become acquainted with the relief not only from the qualitative but also from the quantitative aspect.



Geomorphological survey of Poland. Areas mapped in 1950—1955

In order to obtain an exact morphological characterization of an area, it is not enough merely to determine a number of forms of certain genesis and age, but it is also essential to know their distribution and mutual relations *(8)*.

Geomorphological survey is not only a question of making a map. It is concerned with the shifting of geomorphological studies on to more detailed, more systematic investigations of the relief of the earth surface.

As a geologist examines the structure of the earth's crust yard by yard, so should a geomorphologist study its relief. It is difficult to imagine a geological dissertation not based on the geological survey of the whole terrain, but only on that of a few selected places — as is occasionally the case in geomorphological works. In comparing the development of geomorphology with that of geology, therefore, it must be confessed that the former science is still in the "prospecting" stage, the stage of recording and interpreting single facts.

Previous investigations aiming at knowing the relief of a certain region did not include all the forms appearing in the region investigated, but were limited to the examination only of certain selected forms. The result of such investigations was a description of morphological forms or regions, supplemented by drawings, sketches or photographs. To such a description there were often, but not always, added maps showing the distribution only of selected forms, and these were often given on a white background, and so completely unrelated to other forms in their vicinity.

Investigations of this kind, limited to certain forms and often unrelated to other forms, give an incomplete picture of the relief, and so are of limited scientific value and practical use. In order to obtain a full picture of the relief and knowledge of the full geomorphological development of a certain region, it is necessary to examine all forms.

The investigation of all forms appearing in a certain region necessitates their recording on a map, and so the application of the method of geomorphological survey.

PRINCIPLES OF THE SURVEY

Geomorphological survey consists in putting all forms recorded during field work on a topographical map by means of conventional signs, true to scale, having first given their description and measurement as well as their genetic and chronological classification.

The result of the geomorphological survey is a detailed geomorphological map on a scale of 1:25.000 or 1:50.000. This map, like a geological map, must be based on field work, and not compiled at the desk.

A geomorphological survey cannot be restricted to the recording and localization of land forms of definite origin, as was the case in the first stage of our work on the Geomorphological Map of Poland (*8*). By means of mapping we must endeavour to learn the development of the relief, to solve the chief problem of geomorphology, which is to find out the geomorphological development of a certain region, and to recognize the further developmental tendencies in relation to other elements of the natural environment undergoing changes in the course of this development. We must therefore reconstruct this development against the background of the geological structure and in relation to the climatic, hydrographical, vegetation and soil conditions which prevailed in different periods of this development.

A geomorphological map must be so constructed that the development of the relief may be easily read. In order to fulfil this task, the principle of a chronological genetical classification of land forms has been introduced, both in the course of investigations and also in the actual drawing of the map. The investigation of forms cannot be limited to the determination of their origin, but must endeavour to determine the age of each form and the conditions under which it arose.

The introduction of a chronological genetical classification in the map enables the reader to gain an idea of the distribution and mutual relations of forms of varying origin (e. g. denudative, fluvial, fluvioglacial, etc.) and of varying age from the oldest to the youngest (Palaeogenic, Neogenic, Pleistocene, Holocene, etc.), and to decipher the history of the development of the relief and foresee its further developmental tendencies.

In 1952, on the basis of the rich observational material collected in the first stage of recording for the Geomorphological Map and other studies and experiments, the writer elaborated the chronological classification of the origin of forms in the basin of the Dunajec River *(9)*. In 1954, with the cooperation of Professor R. Galon for the lowland forms, *The Genetic and Chronological Classification of Forms Investigated and Mapped for the Geomorphological Survey of Poland (6)* was worked out.

In this classification were compiled and classified according to age and origin, the forms hitherto observed on Polish territory, arising in the Paleogene, Neogene (Miocene, Pliocene), Pleistocene (in the particular glacial and interglacial periods), and Holocene (Upper and Lower) as a result of the destructive or constructive activities of factors whether internal (tectonic forms) or external (forms having their origin in denudation, karst processes, suffosion, fluvial, nival and fluvioglacial processes, glaciation, buried ice forms, aeolian, lake, sea, plant and anthropogenic processes).

The influence of external forces, as well as the dimensions and course of the orogenetic processes, if they are of importance for the relief of the terrain under investigation, may all be reconstructed on the basis of the distribution and mutual relations of these forms of various origin and age (according to the distribution and situation of the surfaces of the planation, the character and course of the valleys, the distribution and situation of eroded river terraces, etc.). In this way the development of the relief of the terrain under investigation may be deciphered.

PRINCIPLES OF MAP CONSTRUCTION

Forms of which the origin and age have been defined during field work and, as far as the scale of the map permits, the elements of forms of known origin and age (e. g. the slopes of large valleys) are drawn on a detailed hypsometric map (1:25.000 — 1:100.000) by means of colours and signs. The colours are chosen so as to give information on the origin (factor and process) and on the geological age of particular forms. The colours thus indicate which factors sculptured the surveyed terrain, and when (age), and whether by constructive or destructive action. For example different forms created by the destructive action or rivers and denudative processes of the Pleistocene Age are marked by various orange signs. Green symbols mark the various forms created by the constructive (accumulative) action of rivers and denudation during the Pleistocene.

The Geomorphological Map of Poland gives information not only on the origin and age of accurately localized forms, but also on certain morphometric features. The symbols with which the forms or their elements are presented are true to scale, and so give information as to the actual dimensions of the form. The absolute or relative height may be read from the contour lines, since the map is being drawn on a hypsometric basis. The depth or height of small forms (ravines, gullies, edges, river terraces, changes in gradient etc.) is marked by means of the thickness of the lines, the degree of the hatching etc., and the inclination of the slopes by means of the shading of the colour defining the age of the form of which the slope is an element *.

In this manner the geomorphological map gives information on the appearance (morphography) and dimensions (morphometry) by means of symbols, and on the origin (morphogenesis) and age (morphochronology) by means of colours. Hence the map contains all the elements and data essential for the recognition of the character of the relief and its development.

This development, however, following the principles accepted for this map, should be considered (reconstructed and anticipated) on the basis of the geological structure and in connection with other elements of the natural environment changing in the course of this development (climate, waters, soils, vegetation).

In order to trace the relation of forms to geological structure, for the consideration of the development of the relief on the basis of the lithological (resistance) and tectonic structures, it is desirable to introduce data relating to the lithology (resistance) and tectonics of the substratum. These data, however, together with hypsometry, should constitute the background, not obscuring the fundamental content of the geomorphological map. In no case may these data either replace or limit the morphological content (cf. the structural-morphological and so-called morphological maps in e. g. M a c h a t s c h e k's *Das Relief der Erde).*

In order to show the influence of other elements of geographical environment on the development and distribution of forms, chiefly Holocene (contemporary), supplementary maps are sometimes drawn showing rainfall, the hydrographic relations, soils, and the land utilization.

The explanatory text giving a description of the morphological development of the territory under investigation and the further developmental tendencies in relation to other elements of the natural environment changing in the course of this development, with full documentation, forms the complement and supplement to the Geomorphological Map of Poland.

THE CRITERION OF DETERMINATION OF THE ORIGIN AND AGE OF FORMS

The determination of the origin and especially of the age of forms usually presents much difficulty, and necessitates a more penetrating investigation of land forms and of the materials of which they are constructed.

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* See enclosed map.

The determination of the origin (genetic classification) presents no difficulty in the case of typical forms. There are, however, not many forms of this sort, e. g. in the Flysch Carpathians. The great differentiation of forms belonging to the same genetic group, and the great deviations from the "typical" (textbook) forms, necessitates a further extension of the systematics of the origin of forms, either on the basis of study of their present development (e. g. small valley forms, young landslides, etc.) or in the case of older forms, on the basis of the reconstruction of the forces and processes which have shaped them, supported by morphological and morphometrical data and material originating in destruction or construction (geological data).

Still greater difficulties are occasioned by the determination of the age of forms. Here we are concerned not with the morphological age, determined on the basis of morphological and morphometric characteristics (young, mature, or old age forms), but with the geological age (Holocene, Pleistocene, etc.). We deduce the age of the forms arising as a result of the destructive action of various factors, on the basis of the relation of these forms to the dated formations (sediments) and the forms which they are cut into (the lower limit of age), and to the dated formations with which they are lined (the upper limit of age). The age of the forms may also be determined on the basis of their characteristic features, closely connected with definite and dated climatic conditions.

We deduce the age of the forms produced as a result of the accumulative action of various factors on the basis of the character of the sediments (lithological, petrographic, and morphometric characteristics), of the content of plant and animal remains and prehistoric artifacts, and of the relation of these last to form, formations and phenomena of definite age (solifluction mantle, loess, frost disturbances, etc.).

In the mountainous and highland regions of Southern Poland, formed since the Palaeogene, the Miocene deposits enable the Palaeogene to be differentiated from the Neogene. The Neogene forms are distinguished from those of the Pleistocene by glacial and fluvioglacial deposits. The Pleistocene forms are divided from the Holocene by periglacial waste mantles, solifluction covers, and loess accumulations. The previously-mentioned criteria and the method of geological correlation are applied for the further dating of forms within the Palaeogene, Neogene, Pleistocene and Holocene. For instance, we deduce the Lower Pliocene Age of the Carpathian Hill-land surface of planation (grading) on the basis of its connection with the Pannonian (Pont) deposits of the Hungarian Basin. We deduce the Upper Pliocene age of the Carpathian valleys on the basis of an incision in this Lower Pliocene surface of planation and on the basis of old Pleistocene deposits lying on the bottom and slopes of these valleys, and containing in the Carpathian valley mouths an addition of material of glacial origin left behind by the Cracovian Glaciation (Mindel).

We deduce the Pleistocene and Holocene age of small valleys and the deepening of certain large valleys on the basis of their relation to Pleistocene terraces and gravel coverings and to solifluctional coverings and loess. The Pleistocene valleys are lined with these sediments, while the Holocene valleys are incised into the sediments of the last Glacial Period (chiefly in periglacial waste mantles, in solifluctional coverings and loess).

In the Polish lowlands, formed in the Pleistocene and Holocene, we distinguish Pleistocene and Holocene forms on the basis of their character and their relation to the glacial and periglacial sediments, forms, and phenomena connected with the period of the last glaciation. It is due to J. Dylik that attention has been turned to the role of periglacial denudative processes in the morphogenesis of the Polish lowlands *(3)*.

In these investigations aiming at the knowledge of the genesis and age of the forms, of the factors and reconstruction of the processes modelling the region investigated in the particular geological periods, not only geomorphological but also geological, sedimentological, palaebotanical, pedological and other methods should be applied. For the knowledge of the course and the rate of the present destructive and constructive geomorphological processes, observations are already insufficient, and measurements are essential. The observation, investigation, and mapping of the Holocene forms now developing as a result of the action of flowing water (e. g. ravines and gorges, escarpments, alluvial cones), denudative processes (e.g. landslides, soil-creep, talus cones), wind (e.g. dunes, deflated hollows), sea water (cliffs, beaches, spits), etc., lead to the recognition not only of the present course of modelling of the earth's surface, but also to the anticipation of further developmental tendencies.

THE SCIENTIFIC AND PRACTICAL IMPORTANCE OF THE GEOMORPHOLOGICAL MAP

The geomorphological survey of which the result is the geomorphological map, does not only give a good knowledge of the relief, but also enables proper comparative studies to be carried out, the comparison of forms produced or arising at the same time in various climatic zones. This is a particularly topical question at present, when "climatic geomorphology" is becoming increasingly developed in opposition to "structural geomorphology".

Forms and the processes to which they owe their origin have been hitherto scrupulously observed and described; a photograph or drawing is sometimes added to the description. Such a description (e.g. karst forms in various climatic zones) gives a certain view of the character of the process and the form, but does not give any view of the dimensions or force of the process, expressed not only in the quality but also in the quantity of the forms, nor does it give a view on the relation of these forms to earlier and later forms.

The geomorphological survey in regions of various structure and various climatic conditions will enable a much more accurate knowledge of the development of the relief.

Geomorphological maps of various regions will allow comparison with respect to the quality and quantity of forms of the same age (e. g. the Holocene), and so an accurate knowledge of the part played by the climate in the formation of the earth's surface, and will permit the differentiation of the climatic types of relief. The knowledge of the course of the present formation of the relief, e.g. periglacial regions or regions with a humid tropical climate (of a course recorded on the map) will enable studies and comparative conclusions to be drawn with reference to the formation of the preceding relief, e. g. the Pleistocene or Pliocene in Poland.

Thanks to the chronological and genetic classification, which enables the differentiation of older and younger forms and because, of the attention paid to Holocene forms, their development and the perspective of their development, the Geomorphological Map of Poland presents not only a full picture of the relief and its development (dynamics), but also gives an idea of the distribution of forms favourable and unfavourable to human economy *(15)*.

This knowledge enables proper planning of land utilization of a given region. A knowledge of the laws governing the development of these young forms and a knowledge of the conditions of their development make it possible to fight efficiently against unfavourable processes and forms (e. g. ravines, landslides, etc.) and facilitates the mastery and transformation of natural environment.

For this reason the Geomorphological Map of Poland is not only of scientific value, forming a basis for theoretical considerations, but at the same time possesses an economic and practical value.

This double importance of the map, both scientific and practical, compels the geomorphologist who is investigating and mapping a certain region to take a twofold view of every form, process and phenomenon; from the scientific aspect (when, how, and under what conditions a given form arose) and from the practical and economic aspect (what value it has in the economy, and how it may be utilized).

The twofold view, the twofold aspect of these investigations is most certainly very beneficial to the development of geomorphology.

So wide an approach, ensuring the development of science, is possible primarily in states with a planned economy, when the results of investigations on the geographical environment and its elements (e. g. the relief) are made use of for practical purposes, with the aim of a better mastery and utilization of the natural environment for the benefit of society.

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THE DETAILED HYDROGRAPHICAL MAP OF POLAND

One of the most important geographical undertakings in Poland is a hydrographical map on a scale of 1:50.000. The project of such a map, based on the hydrographical survey of Poland, was presented at the First Congress of Polish Science (1951). It was recognized as one of the main tasks of Polish geography.

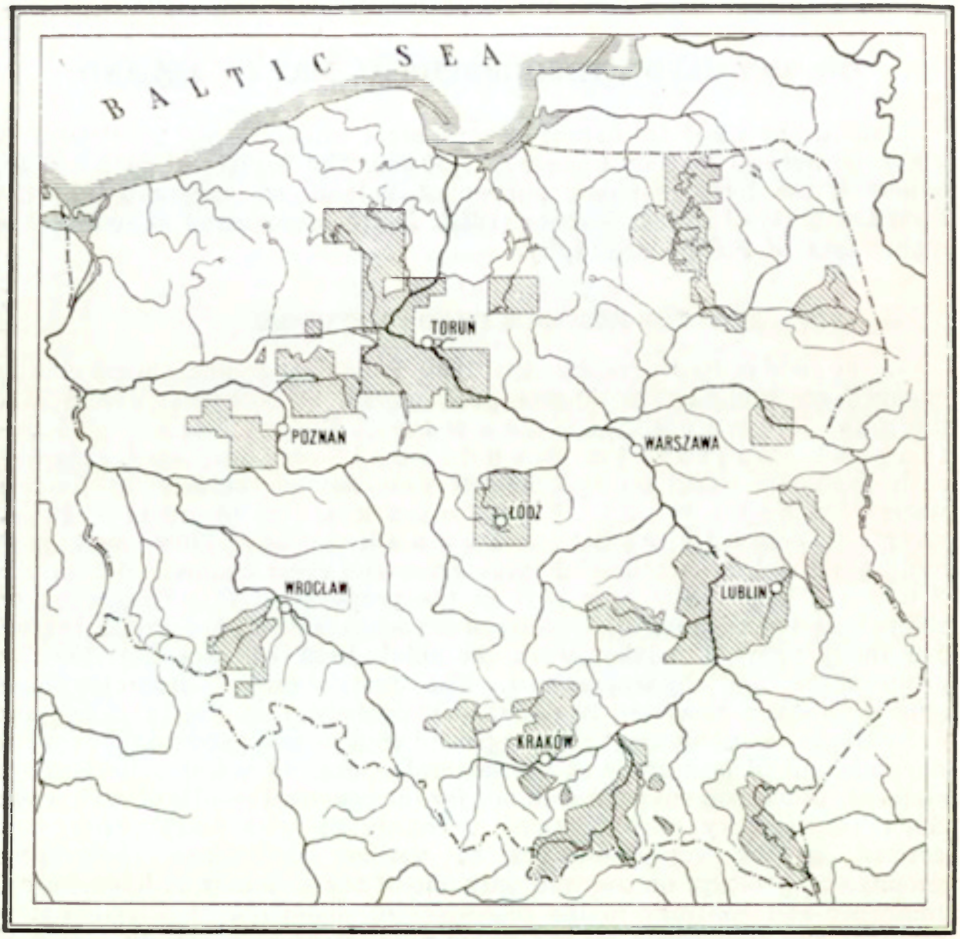
THE PREVIOUS FIELD OF STUDIES

In the field of hydrography until 1950, Polish geographers were chiefly engaged on limnological studies particularly on bathymetry and lake thermics (S a w i c k i, L e n c e w i c z, P a w ł o w s k i, S z a f l a r s k i, B a j e r l e i n, K o n d r a c k i, etc.) and, less frequently, such problems based on hydrometric data as the thermics of flowing waters (S r o k o w s k i, P a w ł o w s k i), the ice cover of Polish rivers (Ł o m n i e w s k i, P a c z o s k a), etc. They also gave hydrographical descriptions of large areas and river basins (R o m e r, S a w i c k i), they took part in the preparation of monographs on rivers [1], and catalogued the results of investigations on the Polish lakes [2]. For many years, the lakes were the chief field of investigations for geographers and hydrographers. The restriction of hydrographical studies to lakes, however, like that of hydrological studies to rivers, and of hydrogeological studies to underground waters, was good neither for the development of hydrology as the general science of water as one of the elements of natural environment, nor for the practical results of such work. Such fragmentary investigations unconnected with each other, and carried on by representatives of various disciplines (geography, geophysics, geology) on one and only one of the elements of hydrology is improper and contrary to the principles of dialectics. It is essential to consider and investigate all the water phenomena in a certain region in their mutual relationships, as well as in their connection with other elements of the natural environment. From such premisses arose the conception of the Hydrographical Map of Poland. The question was then to interest geographers specializing in hydrography in all hydrographical questions, and to encourage them to make systematic field investigations on the whole of the water conditions in the regions of the particular river basins in Polish territory.

[1] E. g. *Monografia Odry* (Monograph of the River Odra). Poznań 1948.
[2] *Katalog jezior polskich* (Catalogue of the Polish Lakes). Warszawa 1954.

PRESENT STATE OF RESEARCH

In 1951-52, work on the Hydrographical Map of Poland was being carried out in only a few centres (Cracow, Łódź, Poznań) [4], while since 1953 it has been in progress in all Polish university centres. During the period 1951-54, the hydrography of an area of 32 000 square kilometres was mapped, and in 1955 an area of 11 700 km^2.



Hydrographical survey of Poland. Areas mapped in 1950—1955

The investigations are being carried out by scientific workers from the Geographical Institute of the Polish Academy of Sciences, as well as from the staff of the university departments of Geography, especially of Physical Geography. From 80 to 130 persons annually take part in the field work. These are mainly university lecturers, graduate students and senior students, and with increasing frequency teachers of geography from the secondary schools. The task of the Cracow and Toruń Hydrography sections of the Geographical Institute of the Polish

Academy of Sciences is the planning, coordination and control of investigations, improvement of methods of research, and the elaboration of instructions *(3)*, etc. The department in Cracow is in charge of the investigations for Southern, and that in Torun for Northern Poland. The results of investigations are presented, methods of work discussed and approved, and scientific problems considered, at special meetings *(4, 4a)*.

In the first years there was a free choice of the terrain to be investigated, but since 1952 the area has been a matter of agreement with the State Committee of Economic Planning. According to the requirements of the organs of planning, hydrographical investigations have been carried on in the river basins of the Dunajec, Kamienna, Brda, the Central Vistula, the Upper San, in the region of the Wieprz-Krzna canal, the Kujawy, in the Upper Silesian Industrial District, the Sub-Tatras, etc. The field of hydrographical investigations frequently coincided with the area of geomorphological survey. These studies constituted the first stage of complex investigations on the whole natural environment. The distribution of the areas investigated in connection with the hydrographical survey is shown in the accompanying map.

Two stages are marked in the process of preparing the Hydrographical Map of Poland. In the first phase, the hydrographers were restricted to recording and describing the water phenomena and objects on maps on scale of 1:25.000 or 1:100.000. During this time, they had not yet a clearly defined scientific problem, and their endeavours lay rather in the direction of helping hydrologists in the cataloguing of the surface water supplies. Since 1953, the hydrographers were given, as their chief target, the task of getting to know the circulation of the waters in particular river basins in connection with the other elements of the natural environment *(4a)*, i. e. an investigation and consideration of the circulation of water in connection with the geological structure and the relief, the soil, climatic and plant cover relations, and their economic utilization.

THE PRINCIPLES OF HYDROGRAPHICAL MAPPING

With the aim thus defined, the hydrographers undertook the hydrographical survey of Poland. Hydrographical mapping consists in registration on a topographical map (scale 1 : 25.000), of all water phenomena and objects found on the territory under field investigation, after previously describing, measuring and classifying them. It consists also in registering and localizing on a topographical map all possible phenomena of water circulation, and its relations to the natural environment. The hydrographer must be constantly aware of the role and function of particular phenomena in the water circulation of the area investigated. His task is observation and registration of all the phenomena of water circulation in the territory from the time it falls as precipitation until the time of its evaporation or outflow from the river basin under investigation. The meteorologist supplies him with information on the quantity of precipitation, and hence the quantity of water introduced into circulation in the area of the river basin under investigation. The hydrographer should trace the further fate of this water, investigate the course of soaking, evaporation, accumulation in surface and underground reservoirs, outflow in the form of springs, and finally the underground and surface outflow in the form of sheet flow and surface drainage. Accordingly the hydrographer ought, in his hydrographical survey, observe, record, examine, and localize all those water phenomena and objects which render it possible to gain a knowledge of underground retention (reservoirs of underground water), temporary retention (bogs, marshes, quagmires), surface retention (lakes, ponds), sheet and linear flows (surface drainage). This extensive field of investigations and complex treatment differentiate the hydrographer from the hydrogeologist, whose work is limited exclusively to underground waters *(1, 2, 7, 8)*. Recently, in 1955, it was announced that work had been started on a Hydrogeological Map of Poland on a scale of 1:300.000, on the basis of bore-hole, geological and hydrological materials *(6)*.

Underground water reservoirs are determined and marked on the basis of analyses of springs, wells, bore-holes and damp ground, connected with the knowledge of the geological structure of the area under investigation (permeability, water-bearing strata, and impervious strata). Information on the distribution and capacity of underground water reservoirs in mountainous areas is given chiefly by springs, while there are wells, bore-holes and damp grounds *(10)* which give information on the distribution, depth and capacity of underground water reservoirs in highland or lowland regions or within the valley bottoms and intermontane basins, as well as pits in mining districts *(5)*.

Permanent and periodical peat-bogs, permanent and periodical marshes, and partly overgrown lakes, i. e. quagmires (reservoirs of water under a plant cover), are investigated and mapped as temporary retention reservoirs.

The ranges of damp ground at various seasons of the year, the consistency of the quaggy layers, and their origin, should be investigated.

Both natural (lakes, oxbow lakes) and artificial reservoirs (fishponds, pools, dam reservoirs, irrigation furrows) are investigated and mapped as reservoirs of surface retention. The form of the lake basin (bathymetry), the fluctuations in water-level, the thermal conditions, freezing, optical phenomena, progress of overgrowth, etc. are also investigated.

The hydrographer seeks to gain a knowledge of the character and course of the inflow and outflow of surface waters by the investigation and mapping of all springs and streams of every kind (permanent, periodic, and episodic). The places in the stream beds where water appears and disappears are noted and mapped (fissures, river rock waste, bogs), as well as overgrown and damaged sections of beds, sand or pebble (gravel) banks, waterfalls, and rapids, and all artificial constructions such as stone troughs, stairways in the beds, gravel barriers, mill-races, irrigation furrows, canals, embankments, etc. In addition, areas flooded annually or in time of disastrous inundations are marked on the map.

Measurements of the speed of flow and temperature are also carried out, as well as observations on the course and duration of freezing, transport of material rolled along or in suspension, as well as pollution by town or industrial sewers.

Field work is carried out in summer (July and August), and is limited mainly to single measurements and observations. e. g. the yield of springs, depth of the water table, volume of flow, etc. The Hydrographical Map therefore presents the hydrographical data characteristic of and proper to the period in which they were observed. For this reason, the period of the investigations is always noted on the map resulting from the survey. This renders it possible to link up single but dated observations and measurements with the regular daily observations and measurements carried out by the stations of the State Institute of Hydrography and Meteorology measuring precipitation, river water-level, and ground water-level. Such linkages give an idea whether the hydrographical relations observed in a given period of time are characteristic of a period of high or low precipitation and of the high, medium, or low water-levels.

The lack of regular measurements and observations of every mapped phenomenon carried out over a longer period of time is certainly a serious defect, and lessens the value of the map. In order to prevent this, at least partially, we collect information from the local population, e.g. on changes in the yield of springs, the range of damp ground, the fluctuations in the water-table in wells, lakes and rivers; on the regularity of streams, the range of floods, ice-covers, etc. An attempt is also made by gaining the co-operation of teachers and even of school-children in the carrying out of regular measurements and observations (e. g. every ten days).

The Hydrographical Map gives information on the distribution, situation, and depth of reservoirs of underground water, sometimes on the resources and direction of the flow of underground waters, their surface outflow in the form of springs, seepages, and marshy places, the quantity of water flowing out during the period under observation, on the forms and directions of the sheet-flow (permanent, periodic, and episodic streams), the approximate volume of the flow at average water-level, the range of flood waters, the transport of rock-waste, and finally on the pollution of rivers.

Thus, the Hydrographical Map considerably advances the knowledge of the water conditions in Poland, but we are aware of shortcomings. The Hydrographical Map gives a great deal more than the topographical map which has hitherto been the only and very inaccurate source of information as to water conditions, specially the river network and damp grounds. It gives a general view of the hydrographical conditions but it does not give their full picture *(9)*. The preparation of a hydrographical map, giving an idea of the circulation of water within particular, sometimes even small, river basins, and the water conditions of each region, requires a great deal of work, a closer network of stations measuring precipitation, river water-level, ground water-level, and evaporation, and an increase in the number of observers and research workers; it demands the co-operation of hydrologists, hydrogeologists, and hydrographers.

The contents of the Hydrographical Map of Poland now being drawn are as follows *(3)*: the water phenomena and objects have been drawn on the hypsometric map (scale 1:50.000) showing the orographic relations, by means of the standard signs as given in the table of signs to the Hydrographical Map of Poland. In this table all phenomena and water objects are set out according to the successive stages of water circulation.

THE THEORETICAL AND PRACTICAL VALUE OF THE HYDROGRAPHICAL MAP OF POLAND

The Hydrographical Map, even in its present incomplete state, has undoubtedly advanced the knowledge of hydrographical conditions in Poland. It gives the localization and registration of all water phenomena, in this way constituting a basis for all investigations on water circulation. It gives, however, not only the distribution of particular phenomena and objects, but also their relations to other elements of the natural environment — to the relief, and to the geological structure. It also renders possible an exact hydrographical characterization of the area represented.

The Hydrographical Map is at the same time of great practical interest. It gives an idea of the distribution and depth of underground water reservoirs, the thickness of the zone of aeration, the distribution and character of springs (yield), the distribution of damp and flooded grounds, the course and character of streams, and finally enables the determination of the regions with water surpluses or deficits. It therefore gives an idea of and information on all those data which are of particular importance in agriculture, forestry, industry, water supply and sewage etc., and so in the water management. A serious shortcoming is the lack of quantitative data. In this direction, the supplementation and enrichment of the contents of the Hydrographical Map of Poland must be furthered. Finally, the value of this map lies in the fact that it encourages and compels geographers to study water as an element of nature, and to complex consideration of circulation of water and all water conditions.

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NATURAL REGIONS OF POLAND

Recent years have, both in the Soviet Union and in Eastern and Western Germany, breathed new life into regional physical geography. In Poland also has arisen the problem of revising the scheme of regional division, hitherto universally accepted, and of defining with greater precision the criteria for regional division in accordance with the principles of modern physical geography *(7)*. At present, the boundaries between the several territorial units are not drawn merely on the basis of their external features; such units are conceived of as being spatial complexes which form a unity of mutually conditioned factors and phenomena, distinguished by a well-defined development trend and specific features *(6)*. Knowledge of the intrinsic interdependences between the several components of such units is absolutely necessary for the purposes of a rational exploitation of Earth's natural resources; no wonder, therefore, that the development of physical geography has been given a new impulse, both on the part of the authorities concerned with economic planning, and of town-planners in their projects of new housing estates and urban districts. The literature dealing with problems of regional physical geography is today extremely comprehensive, and it has already been many times reviewed and discussed; hence, we propose only to draw our readers' attention to a few of the more recent contributions, as a starting-point in presenting the characteristic features of the most important regions of Poland from the point of view of physical geography.

Even though to the notion of basic physico-geographic unit there has not, so far, been applied an unequivocal definition, yet the old physiognomic point of view is, generally speaking, nowadays dismissed. In this connection, it is worth while to consider the most recent methodological attempts made in Germany. These include: Paffen's work on the "natural landscape" and on its spatial differentiation *(12)*; Meynen and Schmithüsen's textbook of a division of Germany into "natural areas" *(Naturraume) (10)*; Gellert's division of the German Democratic Republic into physico-geographic regions (2); and the collective work, edited by Schulze, on the "naturally conditioned landscapes" of the German Democratic Republic *(14)*. Each one of such attempts deals with differently conceived territorial units. Thus the concept of natural landscapes involves the picture of Nature which surrounds man, while leaving out of account the alterations introduced by man's economic activities; in the concept of natural areal units, the alterations introduced by such activities are, to some extent, taken into consideration, but settlements and the achievements of industrial technique are omitted. G e l l e r t' s physico-geographic regions are supposed to refer to an actually existing reality from the point of view of natural processes, while S c h u l z e' s naturally conditioned landscapes refer to conditions such as would have existed without human interference — supposedly conductive to accentuating the alterations caused by the development of human society. As a matter of fact, however, all these authors seek to analyse the conditions which prevail in a given natural environment in our own time, a fact which was, perhaps, best formulated by K a l e s n i k when he wrote that the subject of the research carried on by physical geography was the so-called „geographic Earth's cover", which is composed of objectively existing territorial units (landscapes), transformed, to a greater or lesser extent, by the economic activities of human society *(6)*.

The problem of dividing the total Earth's cover into territorial units is closely connected with that of systematizing such units, and of the terminology and criteria on which the selection and delimitation of the units of various degrees ought to be based. The use of a proper geographic nomenclature is here not unimportant.

Many (though not all) authors, both German and Soviet, use the term „Landschaft" (landscape) for describing the basic physico-geographic unit; the Polish equivalent of this word („krajobraz") tends rather to have a purely physiognomic meaning, while areal units are called "regions", following the example of French and Anglo-Saxon geography *(7)*. In P r o k a y e v' s paper on the methodics of delimitation of physico-geographical units, recently published, landscape is spoken of merely in a general sense, and no taxonomic unit bears that name.

For the purpose of placing Poland's territory on a background of larger physico-geographical units and of delimiting smaller units, the writer has suggested a system (7) which might be illustrated as further described, if we omit the highest grades, i.e. Earth's surface, oceans and continents. Within the limits of Europe, the following units would be involved (with reference to Poland):

The geographic zone of mixed forests (the macroclimatic together with the vegetational and soil criterium).

Geographic areas: A. The Central-European Lowlands, B. The Czech Massif, C. The Silesia — Lesser Poland Uplands (Wyżyna Śląsko-małopolska), D. The Lublin Uplands (Wyżyna Lubelska), E. The Subcarpathian Lowlands, F. The Carpathians (the geomorphological and structural criterium).

Geographic areas, in turn, are divided into the following units: natural regions, subregions, microregions, „urochiskos", landscape facies.

The criteria which make it possible to distinguish such lesser units include the following: land relief, climate, water, soils, vegetation, together with the degree to which the natural environment has been transformed by man's activities — that is to say the whole physico-geographical complex. In practice the delimination between any such units, smaller than a geographical area, is most commonly effected by applying the „leading factor" method. On the level of a natural region, which is usually a relatively large unit, stretching over many thousands of square kilometres, such a factor is generally provided by land relief and climate; on the other hand, with units smaller than a natural region the basis for delimitation may be, apart from the geomorphological factor, the type of soils and the extent to which they are exploited by man, together with the various forms of transformation of the natural environment.

If we compare our basic unit, which is the natural region, with the other systems of division, it will be found roughly to correspond to Schultze's concept of „Grosslandschaft" *(14)*, Gellert's „physisch-geographische Region" *(2)*, Prokayev's „rayon" *(13)*, Isachenko's „group of landscapes" *(4)*, and to Milkov's „landscape region". The subregion, on the other hand, would correspond to Isachenko's „landscape", and the microregion — to his „group of urochishches" *(4)*. The concept of „facies", borrowed from the Soviet geographers, has its opposite number in the German geographers' „landscape cell" (*Zelle* or *Fliese*). In this connection Schultze and others oppose the natural landscape cell to a cultivated landscape cell, which is incorrect from the point of view of the thesis which demands that research should bear on actually existing reality.

The University of Leningrad school, headed by Kalesnik and Isachenko, assumes that the „landscape" is a proper subject of research for a physical geographer, who ought to conduct personally the field work involved in mapping since the field research carried out by specialists in such other branches of geography as geomorphology, climatology, hydrology, soil science, biogeography, economic geography, etc. does not concern itself with the analysis of territorial complexes, but only with that of their several components. Obviously such specialised research will be of tremendous auxiliary value to the physical geographer; but, all the same, he cannot rely merely upon materials supplied by others, since by such means, he would never get to know concrete reality. Field research in physical geography, however, can only deal with small units, from subregion („landscape") downwards; on the other hand, the analysis and description of the characteristic features of such territorial units as natural regions (landscape groups) and their equivalents may be based on the analysis of the several components of the natural environment; in the process, we ought to point out the existing correlations and the paleogeographical development which would justify the delimination.

The latter method has been made use of in the delimitation and description of the characteristic features of Poland's natural regions, while it has been assumed that structure and land relief are the leading factors; the latter are, moreover, the best known, and it was possible for the author to take the remaining components of the natural environment studied into consideration only in the most general way. On the other hand, the third existing method of complex regionalization, namely the mechanical superimposition of the boundaries of the various components (*geofactors*), applied in Schultze's book *(14)*, has been disregarded. Hypsometrical conditions have not, as hitherto, been accepted as the leading factor, since this would have led to oversimplification and schematism in failing to take into account the development of the natural environment. There can be no doubt, however, that hypsometric conditions do play an important part as an auxiliary criterium.

The regional division of Poland has been carried out on the basis of the maps contained in the *Atlas Polski* (Atlas of Poland), scale of 1:2.000.000 (*1*), together with supplementary data supplied by the literature of the subject. We omit the problem of division into subregions and smaller units.

There follows a concise description of the sixteen natural regions into which we have divided the territory of Poland.

(A 1) The Western Pomeranian Coastal Region is a low-lying morainic plain, with altitudes up to 100 metres, dismembered by numerous old valleys *(Urstromtäler),* and confined by a straightened-out coastal line in the North. This line is formed by sandy bars with dune dams, which cut off more than ten shallow littoral lakes from the sea. Such lakes are vanishing remnants of lagoons, which had arisen as a result of *Litorina* transgression. The largest of such lagoons, and one which even now has a link with the sea owing to the flow of the Odra waters, is the Szczecin Bay. Former promontories, now graded by the action of the waves, and forming low cliffs, in places reach right down to the sea. The climate of this coastal region is influenced by the masses of polar sea air, coming from the North-West, and by the immediate vicinity of the sea; therefore it exhibits the features of an oceanic climate. The winters are mild (average January temperature about —1°C.), the summers relatively cool (average July temperature about +17°C.); this explains why the annual ranges of temperature here are the lowest in Poland. The duration of winter is of about one month only. The annual precipitation is low (under 600 millimetres). The characteristic natural plant associations are encountered on sea-shore dunes, peat-bogs and heaths, where such Atlantic species as e.g. the *Erica tetralix* can be found. The ground moraine areas are mostly farmland, with brown and podsol soils, while in depressions and old valleys soils are mostly peaty, and around the Szczecin Bay they are sandy, covered with pine forests.

(A 2) The Eastern Pomeranian Coastal Region presents a different morphological type from the foregoing. It surrounds the Gulf of Gdańsk, which cuts rather deep inland, and the southern part of which has been filled up by the Vistula delta. There are no littoral lakes in this region. Two long spits have not yet entirely closed the entrance to the bays. Moraine hillocks of considerable height, and undercut by steep cliffs, reach right down to the sea-shore. There is no great difference between the climate of this region and that of Western Pomerania, except that it becomes more continental as we move East, a fact which finds its expression in the course of the North-Eastern limit of the beech-tree and the South-Western limit of the spruce.

(A 3) The Pomeranian Lake District in its entirety forms a convex relief form, with a diversified young-glacial landscape, surrounded on all sides by old valleys and alluvial plains. The axis of that elevation is formed by the terminal moraines of the

Pomeranian stage, which follow a generally South-West to North-East course, while forming two southward arches on the lower Odra and the lower Vistula. The morainic tops go to higher maxima as we proceed north-eastward, reaching a maximum height of 331 metres. The principal morainic belt constitutes the watershed between the rivers which flow southward to the Vistula, the Noteć and the Warta, on the one hand, and those flowing northward directly to the Baltic Sea. On an area which amounts to about 32,000 square kilometres there are over 4000 lakes, covering 1150 square kilometres, i.e. 3.6 per cent of the area; in the frontal moraine belt, however, the lakes occupy, in places, up to 10 or even 15 per cent. Because of its elevation above the surrounding low-lying areas, the Pomeranian Lake District constitutes a separate climatic region, cooler and more humid than the adjacent areas. Annual precipitation attains its maximum (over 700 millimetres) on the North-Western (i.e. windward) side of the moraine hills, while on the South-East side precipitation amounts to less than 600 millimetres a year. As regards vegetation, the beech is characteristic of the local moraine forests, while the pine prevails on the outwash plains in the southern part of this region.

(A 4) The Mazurian Lake District is, in spite of its typological relationship with the Pomeranian Lake District and with the Wielkopolska and Kujawy Lake District, a region with peculiar and strongly marked individual features. These features are influenced by the North-Eastern geographic situation, by the accumulation of all the passage routes of the frontal moraines of the last glaciation period on a relatively narrow area, and by the presence of Poland's highest percentage of lakes — in an area of 26,000 square kilometres the surface of the lakes amounts to 1450 square kilometres, i.e. 5.6 per cent; since in number the lakes are only 2700, they are on the average much larger than those of the Pomeranian Lake District. The transverse depression, filled by large lakes, divides the area of the Lake District into two lofty domes, of which the western reaches a height of 312 metres, and the eastern — 309 metres. These domes constitute local hydrographic knots, from which waters flow down either directly to the Vistula, or else by a round about way through the Biebrza and the Narew, or to the Pregel and the Vistula Lagoon; the north-western part of the Lake District, on the other hand, belongs to the Niemen water basin. This differentiation between the eastern and the western part extends also to climate and vegetation. While the western part exhibits features approaching those of the Pomeranian Lake District, the eastern part is one of the coldest regions in Poland. Winter here is intensly frosty and longer (more than fifty days of frost), the vegetative season is some six weeks shorter as compared with the western areas, the ground is covered with snow for ninety days, and the lakes are ice-bound for an even longer period (up to four months). At Suwałki, the average January temperature amounts to —4.9°C, the average July temperature +17,9°C, and the yearly average to +6.2°C. The annual precipitation varies between 500 and 650 milimetres. The boundary line dividing the continental climate zone from the oceanic climate zone is shown in the course of the limits of the range of numerous plant species. As far as forest trees are concerned, beechs, planes *(Acer pseudoplatanus)* and oaks *(Quercus sessilis)* are not found in the eastern part of the Lake District, while a northern variety of the spruce does make its appearance. On peat-bogs can occasionally be found tundra remnants, such as e.g. the *Salix Lapponum.* A relatively large percentage of the land is used as meadow and pasture, and the western part of the Lake District is under cultivation to a larger extent than the eastern, which is more wooded.

(A 5) The Wielkopolska (Greater Poland) and Kujawy Lake District is, by contradistinction with the regions described above, to a greater extent dismembered by river valleys, and lakes are fewer. On an area which almost equals that of the Pomeranian Lake Districts there are only some 1700 lakes, with a joint surface of 530 square kilometres. Glacial relief forms were developed during the older (the Brandenburg and Frankfurt) phases of the *Würm* glaciation period, while the highest points are lower than in the Pomeranian and Mazurian Lake Districts, reaching as they do the height of a mere 220 metres in the western part, and as little as 200 metres in the eastern. The belt of Frankfurt Stage moraines, which runs West to East across the very centre of this region is intersected by three transversal glacifluvial channels, made use of by the river Noteć in its upper course, the Warta and the Obra. The Warta has effected the deepest erosion of the three, and re-modelled the former glacial lake channel into a river breach, shifting its course the marginal Warsaw-Berlin old valley in the South to the Toruń-Eberswalde old valley in the North. Climatically speaking, this area belongs to the driest in Poland, a fact which can probably be ascribed to its position within the "rain-shadow" of the Pomeranian Lake District, situated to the North-West of it; the precipitation nowhere exceeds 550 millimetres annually, while in the peripheral valleys it falls even below 500 millimetres. Winter is relatively short (from one to one--and-a-half months), and the vegetative season lasts some six to seven months. Fine beech forests are to be seen on the terminal moraines in the western part of this Lake District, while its eastern part has long been farmland, practically entirely unwooded. On its wide-spreading, sandy old-valley terraces dunes occur and pine forests grow.

(A 6) The Southern Wielkopolska (Greater Poland) Lowlands contrast as a unit with the preceding region by reason of the relief type, which has some bearing upon hydrological and soil conditions. This region also exhibits certain specific features as regards climate and vegetation; these features, the outcome of geographical position, make the region more like highland districts. These differences in relief consist in the lack of young glacial forms with depressions without outlet and with dead ice hollows, as well as in a predominance of periglacial relief features which developed in the *Riss* (Saale) glaciation forms. In the southern part of these lowlands, a characteristic hill range is formed by moraines of the Warta stage, which, resting as they do here upon a somewhat higher-reaching Tertiary substratum, attain, though strongly denuded, a height of 289 metres. Hydrographically, the region falls into three parts: the direct basin of the Odra, the Warta basin, and partly the Vistula basin. Post-glacial lakes are not to be found. Climatically, the central part of this area belongs to the so called Łódź District, characterized by a precipitation of about 600 millimetres, which is similar to that as in the Pomeranian Lake District, and higher than that of the Wielkopolska and Kujawy Lake District. The climatic transition to the highland districts in the South of this region finds its expression in the course of the limits of the range of the beech, the fir, the plane and the mountain spruce.

(A 7) The Silesian Lowlands (Nizina Śląska) differ but little, morphologically, from the Southern Wielkopolska Lowlands. They are also situated within the Riss glaciation area, but outside the Warta stage. The surface of this region is covered, over extensive stretches, by fine silty material which constitutes the substratum for the formation of excellent soils. The lowlands are through-shaped, with the Odra flowing along their axis, and its tributaries, both eastern and western, forming a symmetric pattern. The features of the local climate are: maximum average yearly temperature in Poland (Wrocław +8.7°C), a short winter, an early and moist spring and a warm summer (average July temperature for Wrocław amounts to +18,8°C). Precipitation is between 500 and 600 millimetres. The vegetative season covers up to 225 days. These climatic properties are connected with the existence in the South-West of the mountain barrier of the Sudeten, which causes the appearance of such Föhn phenomena in the depression as a decrease in humidity, less cloud and a rise of temperature. Favourable climatic and soil conditions have transformed the Silesian Lowlands into an area of cultivated fields, even though there are in its western part considerable tracts of pine forests, on the sandy alluvial cones of the Sudeten rivers. On the other hand, in the eastern part of the Lowlands many steppe elements appear, both in the flora and the fauna, due to edaphic factors and to the destruction by tillage of the original forest plant communities.

(A 8) The Lowlands of Mazovia-Podlasie (Nizina Mazowiecko-podlaska). This region, like the Southern Greater Poland Lowlands, lies, more or less, within the range of the Warta stage of the *Riss* glaciation area; forms of glacial accumulation have survived here only in the shape of remnants of periglacial denudation. Surface configuration reveals, owing to the structure of the Quaternary substratum, the shape of a flat basin. The drainage system comprises Vistula tributaries, flowing concentrically towards the centrally situated Warsaw Basin. The edges of this basin exceed, at their peaks, a height of 200 metres, while the lower part of the Vistula Valley lies from 60 to 100 metres above sea level. As the soil is mostly somewhat sandy, this was originally a land of pine forests; larger fragments of mixed forests have only survived in the eastern parts of the region. Climatically, conditions become more markedly continental as we move eastward. Thus, for example, the average January temperature for Warsaw is —2,9°C, while one hundred and eighty kilometres farther north-east, at Białystok, it is amounts to —4.1°C, with almost identical average July temperatures, that is +18.6°C and +18.4°C respectively. The cooler climate is responsible for the absence from the region of trees characteristic of the western part of the country, such as the plane and beech.

(A 9) The Lublin Polesie forms western part of the great Polesie region, situated to the West of the Bug Valley. The characteristic feature of Polesie is the presence of extensive, sandy or peaty accumulation plains with shallow ground waters, which in places form lakes. These plains are varied by hillocks, comprising deposits of the *Riss* glaciation, modified by periglacial conditions. Shallow-lying Cretaceous deposits occur in the substratum. As regards land utilization, this region consists principally of sparsely populated bogs, meadows and forests.

(B 10) The Sudeten Mountains and their Foothills. The basis for the delimitation of this region is its geological structure and the highland-mountain character of its landscape. This region forms part of a larger unit, the Czech Massif, distinguished by its powerful dislocations of Tertiary faulting, in the shape of ridges of a highly diversified structure. Enormous granite intrusions, rimmed by metamorphic rocks occur here, together with fragments of old Paleozoic folds and of sedimentary Mesozoic mantles. The mountain tops bear traces of peneplain, while tectonic-denudational basins have the form of pediplains. A huge marginal fault divides the area of the mountains proper — from 700 to 1100 metres high — from the foothills, of identical structure, but lying considerably lower between 200 and 400 metres, with the highest monadnock reaching 719 metres (Ślęża). The highest parts of the West and East Sudeten, however, reach heights of more than 1400 metres, the highest peak being 1603 metres (Śnieżka). The climate of the Sudeten Mountains is humid, cool and windy, since the geographical situation expose them to the oceanic polar air masses, flowing in from the western half of the horizon. Szklarska Poręba, a locality situated at a height of 640 metres, has an average yearly temperature of $+5.6^0$C, an average January temperature of $—2.9^0$C, and an average July temperature of $+14.9^0$C, while the summit of the Śnieżka (1603 metres) has a yearly mean of $+0.1^0$C, —7.1 for January and +8.3 for July. The natural primitive vegetation cover has undergone considerable alterations owing to the economic activities of man. The original fir and beech forests have been replaced by spruce monocultures, the highest range line of which runs as low as at 1250 metres, while higher up the *Pinus mughus* appears. On the flat mountain tops can be seen in places peatbogs with remnants of tundra vegetation.

(C 11) The Silesian — Lesser Polish Uplands (Wyżyna Śląsko-małopolska) constitute an independent unit, being both a geographical area and a natural region, because of its not very extensive surface and the similarity of its paleogeographic development. This unit is built of Mesozoic post-Hercynian (Triassic-Cretaceous) mantles, from under which two Paleozoic domes emerge in the western and eastern parts of this area — one of them in the Silesian Uplands and the other in the Kielce-Sandomierz Uplands, with the Createaceous Nida Basin separating them. The whole area underwent strong denudation during the Tertiary, while towards the close of this period there occurred upsurges which caused the cutting down of the valleys. During the Pleistocene, it was covered with products of the *Mindel* glaciation followed by strong periglacial denudation, which left mere tattered fragments of the old morainic mantle. On the North, the boundary of these uplands is pointed out by the area of the continuation mantle of *Riss* glaciation, and on the South — by the tectonic-erosional margin, sinking towards the sub-Carpathian depressions. Hypsometrically, the Uplands as a whole hardly exceed 200 metres, but on the Jurassic lime plateau which constitutes the eastern limb of the Silesian anticlinorium, they reach 400 metres, and even more, over considerable stretches, with the highest peak reaching 504 metres, while in the East, in the Hercynian ridge of the Świętokrzyskie Mountains, separated from the main body by erosion, they rise as high as 611 metres. Climatically, we can distinguish, within this region, the so-called Częstochowa-Kielce district *(3)*, characterized by precipitation up to 800 millimetres, i.e. heavier than in the Central-European Plain, a longer duration of the snow cover (between 50 and 100 days), and somewhat lower temperatures. Moreover, in the "shadow" of the Świętokrzyskie Mountains, in the eastern part of this region, there lies the narrow belt of the rather drier and warmer Radom district. The whole region shows a poor flow-off arising from the occurrence of rocks either permeable or undergoing Karst processes, such as limestone and gypsum. The vegetation in this region is also quite specific; its characteristic features are the occurence of the beech, the plane (*1*) and the fir, and, in the Świętokrzyskie Mountains, also of the Polish larch (*Larix polonica);* thus the local forests show a marked resemblance to those of the Sudeten and Carpathian Mountains. Such differences in vegetation are caused by the diversity of the rock substratum and of soils, the latter ranging from podsol and brown soils to various types of rendzins and chernozem soils, underlain by loesses.

(D 12) The Lublin Uplands is a region distinguishable, by its clear-cut margins, from the plains adjacent to it on the North and South. Structurally, it is a Cretaceous trough, going over into the flat Roztocze anticline in the South-West and sheared off by late Tertiary faulting down to the sub-Carpathian depression. The Roztocze anticline connects the Lublin Uplands with the Podole Uplands in the South-East, while in the East the Lublin Uplands go over into the characteristic forms of ridges of the western part of the Volhynia Uplands, thereby linking up with the great geographical area of the Black Sea Plateau. On the other hand, the western boundary of this region is fairly clearly marked as running along the edge of the Vistula Valley. The tectonic buckling of the Uplands began about the close of the Miocene, which has left traces of a marine transgression of short duration. At the end of the Pliocene, the dissection of the Uplands was more accentuated than it is today, because the accumulation and Pleistocene denudation processes have filled in the valleys to a depth of some dozens of metres. The uppermost surface lies at an altitude of from 200 to 400 metres, sloping from North to South and forming three step-like terraces of the character of pediplains. The river system is adjusted to the land structure and dissects the whole area in such a way as to form a landscape of gently undulating hills, comprising either white marls or limestones, and coated with loess over considerable stretches. Climatically, two districts can be distinguished in the Lublin Uplands — the Lublin District in the West and the Chełm District in the East; this differentiation is a result of the growing predominance of continental climatic conditions as we

NATURAL REGIONS OF POLAND

ON TECTONIC AND GEOMORPHOLOGIC BASIS

by Jerzy Kondracki

Scale 1:4 000 000

Explanation:

- Coastal plains, deltas, river terraces and alluvial plains
- Area of the Wurm glaciation with channel-lakes and death ice forms
- Chief morainic ridge of the Pomeranian Stage
- The southern limit of the Wurm-glaciation
- Area of the Riss glaciation with periglacial forms
- The southern limit of the Riss glaciation
- Graded Mesozoic plateaux with Pliocenic valleys and periglacial forms
- Escarpments
- Graded Archaean and Paleozoic massifs, rejuvenated in tertiary
- Tertiary fault line scarps
- Miocenic plateaux in the Subcarpathian Depression (partly covered with Pleistocene)
- The southern limit of the Mindel glaciation
- Area of Flysch folds
- Cristalline blocs with Mesozoic cover
- Mountains of volcanic origin

A. THE CENTRAL EUROPEAN PLAIN
1. The Western Pomeranian Coastal Region
2. The Eastern Pomeranian Coastal Region
3. The Pomeranian Lake District
4. The Mazurian Lake District
5. The Lake District of Greater Poland and Kuiavy
6. The Southern Lowland of Greater Poland
7. The Silesian Lowland
8. The Lowlands of Mazovia — Podlasia
9. The Western (or Lublin) Polesie Lowland

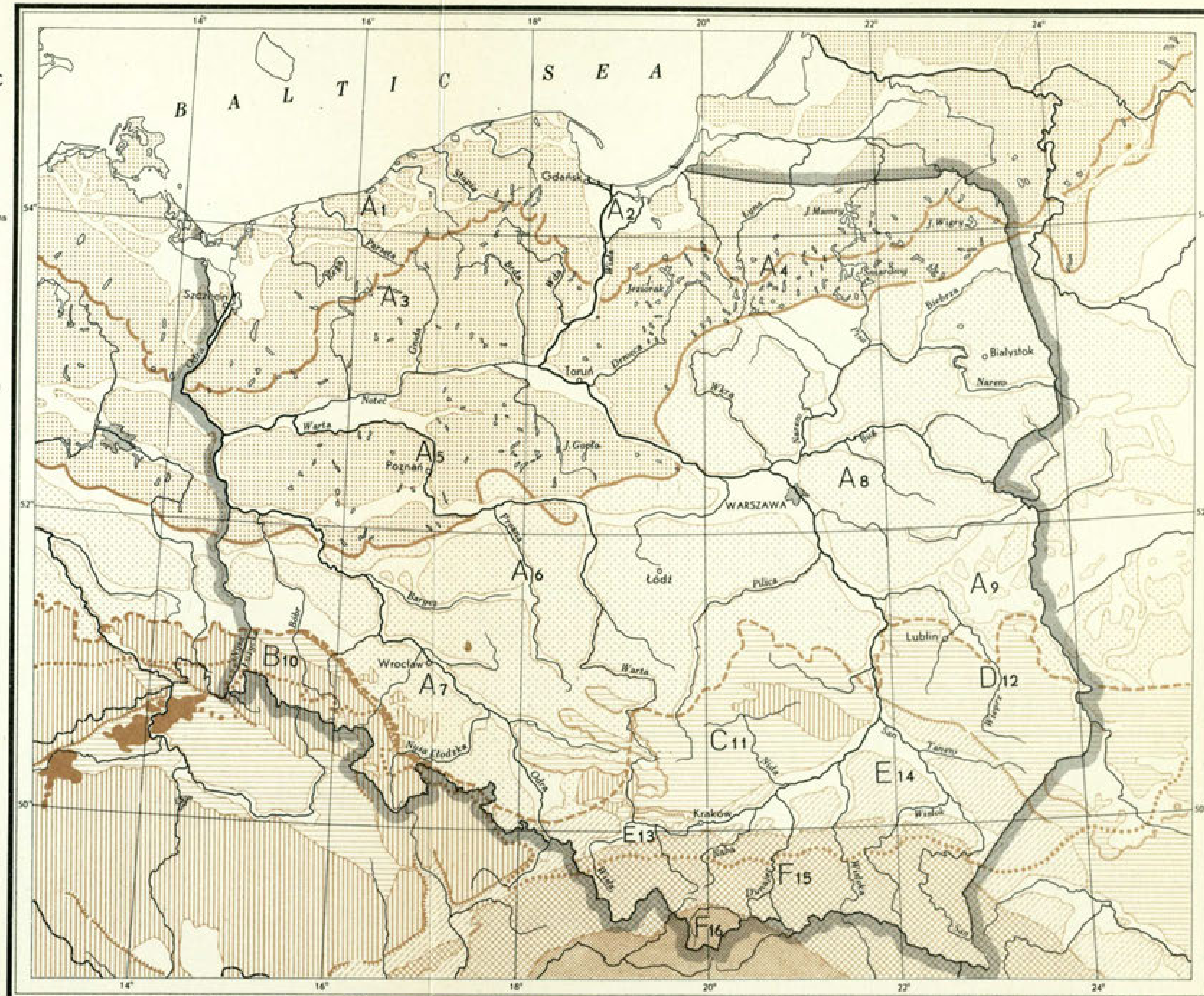
B. THE CZECH MASSIF
10. The Sudeten Mountains and their Foothills

C. 11. THE PLATEAU OF SILESIA — LESSER POLAND

D. 12. THE PLATEAU OF LUBLIN

E. THE SUBCARPATHIAN DEPRESSIONS
13. The Raciborz — Oświęcim Basin
14. The Sandomierz Basin

F. THE CARPATHIANS
15. The Flysch Carpathians (Beskidy)
16. The Western Central Carpathians



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move eastward. These differences find their expression in the course of the eastern boundary of the range of the fir and of the beech, which appear only west of the line of the Wieprz Valley, as well as on the Roztocze anticline. Precipitation here (from 550 to 700 millimetres) is somewhat smaller than on the Silesian - Lesser Polish Uplands; the number of days of frost (about 60) is greater, while the summers are warmer. In Lublin, the average January temperature is —3.5°C, for July +18.4°C, and for the year +7.4°C. The soils are mostly fertile, brown developed on the loess substratum or of the rendzins type, but chernozem soil is also found, particularly in the South-East. Among the natural plant associations, many steppe elements are to be found.

(E 13) The Raciborz — Oświęcim Basin occupies the western part of the sub-Carpathian subsidence area. Overlying fairly shallow-lying Paleozoic foundations, occur deposits of Miocene transgression, covered by strongly denuded products of the older Quaternary period. This region, situated between the Sudetens, the Carpathians and the Triassic escarpments of the Silesian — Lesser Poland Uplands, is connected by means of "entrance gates" with the Sandomierz Basin in the East, the Moravian Basin in the South-West, and the Silesian Lowlands in the North. The basin floor, transversed by the watershed of the Vistula and the Odra, lies at a level of from 260 to 290 metres, while the valleys of these rivers have been cut down some 60 to 100 metres below that level. Climatically and biogeographically, this region is subjected to influences coming from the South-West, through the Moravian Gate.

(E 14) The Sandomierz Basin is an extensive, triangular tectonic depression, situated between the Carpathians, the Silesian - Lesser Polish Uplands and the Lublin Uplands, and filled in by Miocene deposits. The older substratum here reaches down to a depth of 700 metres. Much as in the case of the Raciborz — Oświęcim Basin, we distinguish here two morphologic levels: 1) the upper surface, rising to a height of approximately 250 metres, made up of Miocene deposits and covered by strongly denudated *Mindel* glaciation deposits; and 2) the valley bottoms, filled in by alluvial deposits of the Carpathian rivers, and cutting down to a depth óf from 50 to 80 metres below the upper surface. The soils in this Basin are mostly sandy, and of poor fertility. Their situation at the foot of the Carpathian Mountains ridge finds its climatic expression in the appearance of Föhn-like phenomena, similar to those of the Silesian Lowlands; these phenomena, however, appear only in the western part of the Basin, in the Tarnów District, while the Sandomierz-Rzeszów District, situated farther East, is cooler, less wet and more continental. Thus Tarnów has an average January temperature of —1.8°C, July +19.1°C, and mean annual +8.8°C, while for Jarosław the respective figures are —3.6°C, +18.2°C and +7.6°C. The river regime is a function of the climate prevailing in the mountains — not in the depression — and characterized by frequent catastrophic summer floods, caused by heavy rainfall up in the mountains. Fairly considerable forest areas have still been preserved in this Basin, particularly in its north-eastern part.

(F 15) The Flyssh Carpathians (the Beskidy Mountains) constitute the outer part of the Carpathian area, distinguished by its somewhat monotonous structure and lithological composition. Hundreds of kilometres everywhere reveal sandstone and shale beds, which have been modelled, by relief-forming processes, into hill ranges with rather gentle slopes and summit line. It was only during the Miocene that the mountain-building movements ended here; even during the Lower Pliocene, however, extensive peneplains were formed, cut down to the present-day level of the valley bottoms towards the end of the Tertiary. The Quarternary period brought about no fundamental relief changes. During the glaciation periods, the valleys were filled with gravel, and the slopes were shaped by solifluction, while in the interglacial periods the valleys suffered denudation. These mountains are not high. In their western part, peak altitudes range from 800 to 1400 metres, with only two mountain groups exceeding the level of 1500 metres (highest peak, 1725 metres); in the central part, the summit altitudes do not exceed 1000 metres, and in the eastern part (the Bieszczady Mountains) some peaks rise above 1300 metres (on Polish territory only). The climate of the mountains is characterized by certain continental features, such as a strongly accentuated maximum precipitation in the summer, and a minimum precipitation in winter. Total annual precipitation ranges from 800 to 1200 millimetres. The dependence of climate on orographic conditions is reflected in the existence of vegetation zones; yet practically the entire mountain area lies within the forest zone, with only the two highest massifs, mentioned above, reaching into the sub-Alpine vegetation zone. Easy accessibility to the mountains has caused the destruction of the forests in the lower-lying areas, and their transformation into farmland.

(F 16) The Central Western Carpathians constitute a unit both older and of a much more complicated structure than the Flysh Carpathians. Here, the principal orogenic movements came to an end as early as in the Middle Cretaceous, producing a complicated nappe structure. Nevertheless, during the Tertiary there occurred folding over a wide radius, together with faults, which tore up this area into the several mountain massifs which it now forms, and the depressions between them, filled in by only slightly disturbed Paleogene deposits. Only a small part of this region is situated on Polish territory, and it is composed of three fairly distinct units of a lower order: the Alpine massif of the Tatras, the Podhale Basin, filled in by autochtonic Eocene, and a zone of Mesozoic cliffs which has undergone strong secondary compression. The connecting link between these units is a common tectonic development and mutual geomorphologic correlations; nevertheless, the contrast in landscape between the mountainous bloc of the Tatra Mountains and the Podhale Basin, mostly filled in, is very marked. On the other hand, the Mesozoic cliffs constitute here no more than local accidental landscape features, reaching the greatest dimensions in the small Pieninv group. The Tatras, the highest peak of which — being, at the same time, the highest peak of the Carpathians — reaches a height of 2663 metres. have undergone at least three intensive glaciations, which have produced a typically high-mountain glacial land relief, with cirques, trough-valleys, lakes and waterfalls in the heart of the mountains, while morainic ridges have been piled up at the foot of the mountains, and, in Podhale, gravel sheets have been formed along river valleys. Even nowadays, the climate of both Tatras and Podhale is the most severe in Poland: it has the most prolonged snow cover, ranging, according to height above sea level, from four to eight months, the heaviest precipitation (np to 1700 — 1800 millimetres), mostly during the summer season, while the winters are relatively sunny and dry. The föhn winds here reveal a typical development, and occur most frequently in the spring and autumn. Vegetation exhibits marked variations, in accordance with the ecological conditions: it forms six vertical zones, from the foothill agricultural zone in Podhale up to the region of rocks and snow patches*. Both the flora and fauna here exhibit numerous remnants of the glaciation periods.

In order to give a clearer idea of the size of the regions discussed above, we give the surface of the enumerated units of a higher rank (geographical regions) within the boundaries of Poland:

(A) The Polish Lowlands (9 regions, forming part of the Central European Plain)	227.000 sq. km.
(B) The Sudetens (part of the Czech Massif) . . .	9.500 sq. km.
(C) The Silesia — Lesser Poland Uplands	30.000 sq. km.
(D) The Lublin Uplands (part of the Black Sea Plateau)	12.000 sq. km.
(E) The Sub-Carpathian Basins	16.000 sq. km.
(F) The Carpathians (within Polish territory) . .	17.000 sq. km.

The attached map, scale 1:4,000,000, has been worked out on the basis of a simplified and modified geomorphological map, taken from the *Atlas of Poland,* reduced to half its size.

The above division into regions does not conform with that traditionally accepted in Poland, viz. six horizontal zones, based chiefly on hypsometric conditions, and partly also on structure. The new division takes into account to a greater extent the differences and similarities in the geomorphological development of the several regions, as well as — in so far as possible — climatic, vegetation and soil differences. Unfortunately, our knowledge of the various component factors of the natural environment is still very inadequate. Hence, the regional division suggested above cannot be considered as final, and a closer study of the natural environment will, in all probability, introduce certain modifications, which will find their expression in the distinguishing of a greater number of regional units.

* These vertical zones are: 1. the sub-mountain zone, from 700 to 1000 metres; 2. the fir and beech forest zone, from 1000 to 1250 metres; 3. the spruce forest zone, from 1250 to 1600 metres; 4. the sub-Alpine *(Pinus mughus)* zone, from 1600 to 1850 metres; 5. the Alpine zone, from 1850 to 2300 metres; and 6. the nival and bare rock zone, above 2300 metres.

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THE DISTRIBUTION AND GENETIC TYPES OF POLISH LAKES

The cataloguing, on modern lines, of Polish lakes was initiated by S. Lencewicz. In his work *Limnological Investigations in Poland*, published in 1926, he presented the results of all previous limnological studies, together with a list of the larger lakes sounded. At the same time, work was begun et the Geographical Department of Warsaw University on the collation of a complete catalogue of all lakes situated within then existing borders of Poland, and having an area of upwards of 1 ha. The entire index, comprising 6,659 items, was lost during the war.

A new catalogue, begun in 1946, reopened the investigation of lakes following the war. This work was concentrated in two centres: 1) in Warsaw were studied, under the direction of J. Kondracki, the lakes situated in the basins of the Vistula and Niemen, and of the coastal rivers flowing into the Vistula Lagoon; 2) in Poznań was undertaken, under the direction of S. Majdanowski, the study of lakes in the basins of the Odra and of the Baltic coastal rivers between the Odra and the Vistula.

All work on the lake catalogue was co-ordinated by the Polish Geographical Society, Department for Scientific Investigations, which was also financing this effort. The laborious cartometric measurements, the analysis of data obtained from monographic works, and the later statistical and tabular compilation, were finished towards the end of 1953. Then, the task was referred to the Polish Academy of Sciences Geographical Institute, which published the complete *Catalogue of Polish Lakes.* A general compilation of results and summing up of the catalogue was made by S. Majdanowski in his paper *The Lakes of Poland.*

The publication of the *Catalogue of Polish Lakes* marks the completion of the preliminary, but basic, stage of investigation work on Polish lakes. Relatively accurate data were collected concerning this important factor of natural environment, invaluable in many aspects of economic life as well as in theoretical problems. Thus the *Catalogue of Polish Lakes* achieves an objective set by Polish geographers as long as forty-five years ago.

The next stage of work on the study of Polish lakes will be to complete the archives of bathymetric plans and gradually to take into the investigations all the major Polish lakes.

The Catalogue of Polish Lakes embraces all the natural lakes upwards of 1 ha. in area. This means that it does not deal with the smaller lakes, ponds, and retention reservoirs on rivers.

As regards the basin of the Odra and of the Baltic Pomeranian slope, the study of lakes was based exclusively on maps in scale 1 : 25,000; as regards basins of the Vistula, the Niemen and of the rivers falling into the Vistula Lagoon, various maps were used in the investigations in scale 1:100,000 being the basis, supplemented by auxiliary ones in scale, 1:25,000 and 1:84,000.

In preparing the *Catalogue*, all former studies and lists of lakes were taken into account. Foremost among these are the works of W. Halbfass and A. Seligo, who have listed certain of the lakes of the Pomeranian Lake District. The Mazurian Lakes have been treated by G. Braun and A. Willer. A list of lakes in Greater Poland is given by H. Schütze, lists of the Tatra Mountains lakes by K. Sliwierski and J. Szaflarski, and a list of the Włodawa-Łęczna lakes by T. Wilgat.

The Catalogue of Polish Lakes is divided into 13 sections, each dealing with a definite lake group. This classification sought to take into account the division of Poland into hydrographic and morphologic units. The alphabetical list of lakes in each part of the *Catalogue* contains the following data: — 1) the consecutive number of the lake; 2) name; 3) surface to within 0.1 ha.; 4) height above sea level to within 1 m.; 5) length in metres; 6) width in metres; 7) the geographical latitude and longitude of the centre of the lake to within 0.1'; 8) the appropriate administrative unit.

In addition, the general part of each section of the *Catalogue* includes statistical data showing the number of lakes in the various basins, the area in each case, the height above sea-level, the number of lakes with or without an outlet, as well as a list of the larger lakes, the sounded lakes, and lakes classified according to administrative districts, voivodeships and per sheet of the 1:100,000 maps. Finally, there is, at the end of the general part, a bibliography relative to the lakes in each group.

THE TOTAL NUMBER AND AREA OF LAKES

The total number of all Polish lakes with an area of more than 1 ha. is 9,296, the combined area — 316,927 ha., which is 1.016 per cent of the total area of the country (311,730 sq. km.).

The following table classifies lakes according to size and number:

Size in ha.	Number of lakes	% of total	Area in ha.	% of total
1 — 5	4,734	50.93	10,387.8	3.28
5 — 10	1,316	14.16	9,239.4	2.91
10 — 20	1,091	11.74	15,263.6	4.82
20 — 50	1,043	11.22	32,747.9	10.33
50 — 100	533	5.73	36,783.2	11.61
100 — 1000	545	5.86	136,262.3	42.99
above 1000	34	0.36	76,242.8	24.06
Total	9,296	100.00	316.927.0	100.00

Attention is directed to the fact that the 34 largest lakes account for a much greater area than do the entire 7,184 lakes with an area of from 1 to 50 ha., while the largest of all, Lake Śniardwy, accounts for 3.36 per cent of the combined area of all lake surfaces, i. e. a considerably greater percentage than is covered jointly by the most numerous group of small lakes, comprising 4,734 units.

The following is a list of the largest lakes:

No.	Name of lake	Region	Area in ha	Depth in m.	Height above sea level in m.	Origin
1	Śniardwy	Mazurian Lake District	10,660	25.0	116.0	moraine
2	Mamry	Mazurian Lake District	10,450	40.0	116.0	moraine
3	Łebsko	West Pomeranian Coastland	7,530	5.6	0.3	coastal
4	Miedwie	West Pomeranian Coastland	3,667	42.0	14.0	ice-channel
5	Jeziorak	Mazurian Lake District	3,230	12.0	99.0	ice-channel
6	Niegocin	Mazurian Lake District	2,669	40.0	116.0	moraine
7	Gardno	West Pomeranian Coastland	2,500	2.8	0.3	coastal (and moraine)
8	Gopło	Greater Poland Kuiavia Lake District	2.340	15.7	77.0	ice-channel
9	Jamno	Pomeranian Coastland	2,290	3.0	0.1	coastal
10	Roś	Mazurian Lake District	2.212	26.0	115.0	ice-channel
11	Wigry	Mazurian Lake District	2,166	73.0	132.0	ice-channel

Omitted from the list is Lake Dąbie, a stretch of water at the mouth of the Odra. This lake, having an area of 55.7 sq. km. and a depth of 4.2 m., is of deltaic origin. It actually forms, as is proved by the height of the water level, a part of the widely embranched Szczecin Lagoon.

AREA OF LAKES IN THE PRINCIPAL RIVER BASINS

Of interest are the areas of lakes in the principal river basins and catchment areas on the Polish territory, as shown in the following table:

Basins	Area sq. km.	Number of lakes	Area of lakes in ha.	Lake area in per cent of total area
Baltic:	310,854	9,296	316,927.0	1.019
Vistula	173,725	3,818	129,328.0	0.735
Odra	105,667	3,235	96,004.0	0.908
Coastal Rivers	28,995	2,034	82,424.4	2.842
Niemen	2,467	209	9,170,0	3,717
North Sea:	265	—	—	—
Elbe	265	—	—	—
Black Sea:	610	—	—	—
Danube	382	—	—	—
Dniestr	228	—	—	—
Total for all Poland	311,730	9,296	316,927.0	1.016

The major part of the Niemen basin lies in the zone of the Baltic Lake Districts and almost one half of the Odra basin lies in lake districts. The Vistula basin, however, is mostly outside the lake districts, the limit of lake groupings being far removed northwards.

DEPTH OF LAKES

Taking into account the investigations carried out on the *Catalogue*, 1,113 lakes had, up to 1952, been sonded in Poland, i. e. 11.97 per cent of all lakes with an area of over 1 ha. The total area of lakes sounded was 206,295.1 ha., i. e. 65,09 per cent of all lakes.

The proportion of lakes investigated in each size group is shown in the following statement:

Size class ha.	Total number of lakes	Total area of lakes ha.	Sounded lakes			
			Number	% of total number	Area ha.	% of total area
1 — 5	4,734	10,387.8	72	1.52	215.4	2,07
5 — 10	1,316	9,239.4	84	6.38	617.8	6,68
10 — 20	1,091	15,263.6	99	9.07	1,438.4	9,42
20 — 50	1,043	32,747.9	215	20.61	7,029.6	21,46
50 — 100	533	36,788 2	217	40.71	15,323.3	41.66
100 — 1000	545	136,263.2	392	71.93	105,425.8	77,37
above 1000	34	76,242.8	34	100.00	76,242.8	100.00
Total	9.296	316,927.0	1,113	11.97	206,293.1	65,09

Both the group of Suwałki lakes in the Niemen basin and the group of Mazurian lakes have been fairly well investigated. The smallest proportion of lakes studied relates to the Odra basin, the group placed last being the Pomeranian lakes in the basins of the Notec and of the rivers flowing directly into the lower Odra. Even the lakes of the Greater Poland-Kuiavia Lowland have been subjected to a more thorough investigation. The most thorough studies have been carried out over the Tatra lakes.

In spite of the fact that the lakes to be sounded were selected, and that priority was given to lakes of larger area, the list of maximum depths of lakes investigated does give a general idea of the depths of Polish lakes. The following statement shows that these lakes are mostly over 10 m. in depth, 507 lakes sounded, out of 1,113 (45.5 per cent), being thus classified.

The lakes are divided into depth groups as follows:

Maximum depths of lakes sounded in metres												
0	10	20	30	40	50	60	70	80	90	100	110	Total
	507	296	163	92	32	17	1	3	1	—	1	1,113

The deepest is Lake Hańcza in the Suwałki Lake District — maximum depth, 108,5 m., which makes it one of the deepest lakes in the entire European Plain.

Depths of over 50 m. are considerable, when it is remembered that such giants as Lake Aral or Lake Victoria only slightly exceed this depth, attaining 62 and 79 m. respectively *(5)*. The Polish lakes characterised by the greatest depths are, in the lowlands, channel lakes ("Rinnenseen") and so-called "kettles", and in the mountains, cirque lakes. The latter are of small area but have a disproportionately great depth. The determining factor in the depth of lakes is origin, the principal kinds of action producing great depths being the erosive operation of subglacial melt waters, the eversive action of glacial waterfall or crevass waters dropping from great heights, or the exarative activity of mountain glaciers.

Coastal lakes and those formed by the action of ground moraines are, on the other hand, usually shallow, although of great surface area. The Łebsko coastal lake, with an area of 7,530 ha., is only 5.6 m. deep; the two shallowest of all coastal lakes, Liwia Łuża and Modła, are only 2 m. deep. Lake Wielimie, formed by a ground moraine, has an area of 1,830 ha., but has a maximum depth of only 6 m.; the Polish lake with largest surface area, Lake Śniardwy, has a maximum depth of only 25 m.

The 23 lakes with depths of over 50 m. are all either channel lakes in the lowlands, or cirque lakes in the Tatras.

Some Polish lakes, at their maximum depth or even over the whole base of the bottom, reach down below sea level, forming a so-called cryptodepression. There are 24 such lakes among those sounded.

Cryptodepressions are also formed by inland lakes which have, covering a large part of the bottom, great maximum depths; these fill deep ice-channels, reaching below sea level. The number of lakes with cryptodepressions is probably much greater than at present recorded; further soundings will no doubt reveal a certain number.

VOLUME OF LAKES

The volume of a lake depends not only on the area, but above all on the average depth — an important morphometric index. Lakes with a large area, but low average depth may have a lesser capacity than smaller, but deep, lakes. Thus, for instance, the great Łebsko coastal lake, with an area of 7,530 ha., but with an average depth of only 2.2 m., contains 160 million cu. m. of water, while Lake Drawsko, a quarter that area — 1,862 ha., but with an average depth of 20 m., contains 357 million cu. m. Lake Wielimie with an area more or less equal to that of Lake Drawsko — 1,830 ha. — but with an average depth of 2.7 m., contains only 50 million cu. m.

A review of the lakes sounded shows that the majority of Polish lakes are not of excessive depth. The average depth of 143 lakes of Greater Poland is, according to the calculations of H. Schütze, 6.5 m.; the average depth of the Gostyń lakes, comes, according to J. Jaczynowski, to only 3.6 m. A somewhat greater average depth (8 m.) was recorded by W. Halbfass for the Pomeranian lakes. If 5 m. is taken as the average depth, the volume of all Polish lakes with a combined surface area of 316,927 ha. will amount to 15,846 cu. km. This equals about 1/12 of the total volume of precipitations throughout the country.

LAKES WITHOUT OUTFLOW

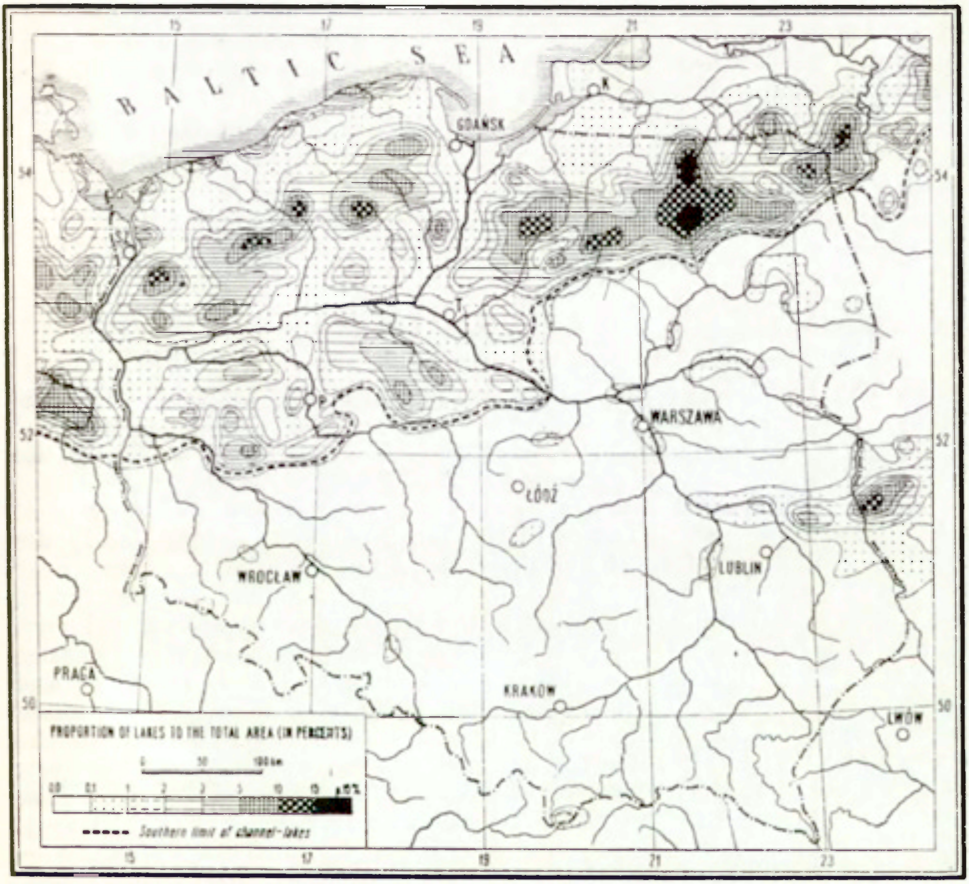
Lakes in considerable numbers have no visible outflow on the surface. The distribution of depressions without outflow is strictly dependent on the morphogenetic character of the landscape of lake districts. The most typical depressions without outflow have persisted in young post-glacial environments. There are also many lakes without outflow on sanders and in dune regions.

The following constitutes a statistical compilation of lakes with and without outflow in the Odra basin:

Size class ha.	Lakes with outflow		Lakes without outflow		Total
	Number	%	Number	%	
1 — 5	546	36.7	943	63.3	1,489
5 — 10	279	54.9	229	45.1	508
10 — 20	307	69.8	133	30.2	440
20 — 50	326	79.5	84	20.5	410
50 — 100	171	87.7	24	12.3	195
100 — 1000	180	96.3	7	3.7	187
above 1000	6	100.0	—	—	6
Total	1.815	56.1	1,420	43.9	3,235

DISTRIBUTION OF LAKES

The proportion of lakes in the total area is shown on the map. This map has been prepared as follows: — the areas of lakes were calculated on basic fields of 100 sq. km. each, and isarythms were drawn according to the following designation: — areas without lakes or where lakes cover less than 0.1 per cent of the area — left white; the subsequent isarythms are drawn for values of 1, 2, 3, 5, 10 and 15 per cent. Also plotted on the map are the southern limits of lake ice-channels.



The distribution of lakes in Poland

An analysis of the map showing proportion of lake areas shows that there is above all a striking difference between the northern zone, abounding in lakes, and the southern zone, almost entirely devoid of lakes.

In the northern zone are grouped 8,401 lakes, i. e. 90.37 per cent of the total number. They have a combined area of 310,069 ha. which corresponds to 97.84 per cent of the area of all lakes. The proportion of lake surfaces to the entire zonal area is 2.676 per cent.

The southern zone, on the other hand, embracing the greater part of the country, has only 895 lakes; with a total area of 6,858 ha. This makes a percentage of only 0,035 of the total area of the zone. The scarcity of lakes in the southern zone is to a certain extent compensated by artificial reservoirs, but even if all these, with a combined area of 35,293 ha., are included, the proportion of stagnant waters rises only to 0.22 per cent. Thus, the difference between the proportion of lakes in the two zones remains enormous.

Nor is the northern zone uniform from the point of view of the density of lake distribution. As the map shows, it is possible to define three great lake district regions: — a) the Pomeranian Lake District; b) the Mazurian Lake District; c) the Greater Poland-Kuiavia Lake District. The proportion of lakes in these regions is shown on the following table:

Lake District	Area in sq. km.	Proportion of lakes				General proportion of lakes in%
		Number	%	Area in ha.	%	
Pomeranian	48,370	4,129	49.15	115,280	37.18	2.383
Mazurian	34,722	2,695	32.08	145,227	47.00	4.183
Greater Poland — Kuiavia	32,768	1.577	18.77	49,562	15.82	1.513
Total	15,8601	8,401	100.00	310,069	100.00	2.676

a) The Pomeranian Lake District occupies the area between the valley of the lower Odra and that of the lower Vistula. In the south it is bounded by the old Warta-Noteć valley, and on the north by the Baltic coastline.

Areas with frontal moraines show a particularly large number of lakes. Isarythms with values of more than 2 per cent follow closely the principal courses of frontal moraines, bend far towards the south near the lower Odra and lower Vistula, into which the glacial tongues forced their way, and run almost parallel to the Baltic coast in the central part.

Starting from the west, it is possible to differentiate four smaller component lake districts: — those of Myśliborz, Wałcz, Drawsko and Kaszuby. The largest absolute proportion of lakes (15.0 per cent) is found in the region of Lake Miedwie in the Myśliborz Lake District. In the Wałcz Lake District, situated further east, the proportion of lakes reaches 6.38 per cent. The central part of Pomerania is crossed by deep lake channels, which occupy in places as much as 12.4 per cent of the area. Finally, there is the Kaszuby Lake District — the most extensive — occupying the highest rise of the whole Pomeranian Lake District belt. Here, the hilly landscape is crossed by deep and powerful lake channels. The largest percentage of lakes is found in the regions of Chojnice — 10.7 per cent.

To the north of the main belt of the Pomeranian Lake District, the lakes disappear. Between the lake district belt and the Baltic coast are pressed extensive planes of the ground moraine, cut up by old valleys, broad and flat. The coastline itself is also characterised by the presence of large areas of stagnant waters. They are the coastal lakes, formed from ancient bays, and separated from the sea by spits of land.

b) The Mazurian Lake District extends between the lower Vistula and the middle Niemen. The landscape of that region differs from others, in that the lakes are concentrated in a relatively restricted space, limited by the lines of terminal moraines; hence the proportion of such to the total area is very high, amounting to 4.18 per cent. Areas devoid of lakes are the waterlogged depression of the Vistula Delta, the Warmia coast, the narrow belt along the lower Vistula valley, and the regions of Bydgoszcz and Toruń.

The highest percentage of lake area is in the region of the great Mazurian lakes with the Lake Śniardwy and the Lake Mamry system. Lake Śniardwy is the largest in Poland with an area of 106.6 sq. km., and a maximum depth of 25 m. The Lake Mamry system lies north of Giżycko and has a total area of 104.5 sq. km. The height of the water level is the same throughout the system — 116 m. above sea level. A third major water reservoir is constituted by Lake Niegocin with an area of 26.69 sq. km. This part of Poland has the highest proportion of lake surface; in the environs of Lake Śniardwy it reaches 36.1 per cent, and in the Lake Mamry system — 34.7 per cent.

c) The Greater Poland - Kuiavia Lake District. This is the southernmost lake district in the entire European Plain. Like the northern lake districts, this one is closely linked with the existence in a given region of terminal moraines. The maximum percentage of lake surfaces in the western part of the district is 3.22. To the north, in the region between the rivers Warta and Noteć, the surface proportion of lakes is 3.36 per cent; in the south, that percentage reaches, near Przemęt, — 6.1 per cent. In the eastern section of the district, there are a number of large chains of ice-channel lakes, particularly the great chain of Gopło lakes, 75 km. long. The largest, Lake Gopło (the so-called "Mare Polonicum"), famous in early history, has an area of 23.4 sq. km. and is 23.8 km. long. In this region, the percentage area of lake surfaces is 8.27.

d) The Southern Zone. The percentage of lakes in southern Poland is extremely small, amounting to only 0.035 per cent. Of lakes with an area of more than 1 ha., 895 have been counted, with a total area of 68.6 sq. km. They are dispersed and of various types: — periglacial, river, marsh, ice-channel, solution, and mountain-glacier.

The Łęczna-Włodawa Lakes form a separate major group, passing towards the east into the Polesie lakes. Within the present Polish frontiers there are 68 lakes of marsh origin, and filling deep subsidences caused by solution processes (22).

Another isolated group are the Lakes of the Tatra Mountains, comprising a total of 120, of which 43 are on the Polish side of the frontier. They are mostly cirque lakes, relatively small in area, but very deep. On the lake map they form, as it were, a small, isolated area, where the maximum proportion of lake surface is 1.23 per cent of the whole. There are two similar lakes in the Sudety Mountains.

Artificial lakes compensate, in part, for the lack of natural lakes in the southern zone. These artificial lakes include retention reservoirs in river valleys, reservoirs for fish breeding or for industrial purposes, and large retention reservoirs for water level regulation on important navigable rivers.

THE GENETIC TYPES OF LAKES

The lowland regions especially rich in lakes correspond to the extension of the ice sheet during the last glaciation. Thus, the origin of the majority of Polish lakes can be traced by way of morphogenetic processes which were the cause of the formation of innumerable hollows in the post-glacial surface. These forms were created by: a) a chaotic glacial accumulation; b) the enclosing and subsequent melting of dead ice masses; c) the erosion of waterfalls in glacial crevasses; and d) the erosive action of waters from melting ice and snow.

In the hilly landscapes of terminal moraines there exist, as a result of particularly uneven accumulation of ice blocks and of the pressure of the edges of the icecap, numerous hollows which time has filled in to form lakes. Two types of lakes may be differentiated here: a) lakes in terminal basins filling enclosed dales or those of irregular or circular shape; b) terminal moraine lakes, occupying longitudinal depressions parallel to moraine mounds and formed through the accumulation of debris pushed down by glaciers.

The origin of ground moraine lakes is the uneven accumulation of material and/or the enclosing of great blocks of dead ice. These are large, not very deep lakes, sometimes with a coastline strangely irregular, and with bays, promontories and islands. In the Pomeranian Lake District one of the largest of this type is Lake Wielimie (1,830 ha.).

Among the lakes of glacial origin are so-called "kettles". These lakes are characterised by insignificant surface dimensions and great depths amounting to as much as 50 m. In shape they are usually rounded or oval, with steep edges. The origin of such forms is attributable to the eversive action of waters from melting ice falling from great heights through the crevasses of glaciers on to the accumulative basement.

The most commonly encountered type, however, in Polish lake districts are ice-channel lakes. These are characterised principally by being long and narrow in shape and being disposed in long series cut up by steps. Investigations have shown that they are not formed by the glacier itself but by the melting glacier waters; thus they constitute the beds of vast rivers near the melting icecap.

Another feature of channel lakes is their disposition in a given direction. Not only in Poland but also in all Baltic lake districts, the predominant directions are closely linked with the principal course of terminal moraines, the lakes being disposed at right angles to them. Since the icesheet invaded the lowland by means of ice lobes, the outwash waters from the melting ice were directed to the outside, and are represented by lake channels disposed in radial systems. There is thus a great radial system within each lobe. The highest density of lake channels occurs in the neighbourhood of terminal zone and the adjacent areas of ground zones.

Mountain lakes of glacial origin are found in the Tatras and the Sudety. There are two types of such lakes, distinguished by the factors which formed the appropriate depressions:

a) Cirque lakes, found at considerable heights; in the Tatras, these appear in two principal belts: — between 1,500 and 1,600 metres, and between 1,900 and 2,000 metres above sea level. Cirque lakes are considerably smaller than the lowland lakes of the Polish lake districts, in shape oval or round, and occupying hollows gouged out of sheer rock by the exarative action of glaciers. Although small in superficiel area, they are of great depth. For instance, Wielki Staw (the Great Lake) in the Dolina Pięciu Stawów Polskich (Valley of the Five Polish Lakes) has an area of 34.1 ha. and a depth of 79.3 metres.

b) Moraine lakes in mountain regions are much shallower and have partly changed into marshes, e. g. the Stawy Toporowe in the Tatras.

In addition to these lakes, there are in Poland others of different origin, having been formed by: — a) the cutting off of maritime bays; b) the filling up with water of depressions between dunes; c) dissolution and subsidence of ceilings in calcareous and gypsum rocks; d) the cutting off of one-time river beds in the valleys of large rivers.

The cutting off from the open sea of bays on the Baltic coast has produced a number of coastal lakes individually considerable in area. The shores of these lakes are flat and marshy, the beds silted; they are divided from the open sea by narrow tongues of dune land, formed by the action of winds and coastal maritime currents. Lake Łebsko (75.3 sq. km., 5.6 m. deep), is the second largest in Poland.

Rain water, or — in favourable conditions — ground water, often accumulates in the depressions between dunes. Thus the land becomes waterlogged, and even shallow dune lakes — particularly numerous in the dune belt between the rivers Warta and Noteć — may be formed. The water level in dune lakes tends to vary — they often dry up to reappear when the ground water table rises again. These ephemeral lakes are also largely connected with the vegetation which maintains the equilibrium in the water balance. The destruction, in 1923, of forests by the pine moth in the Warta-Noteć dune area, caused new lakes to appear.

The subsidence of the ceiling of calcareous and gypsum basements causes the formation of Karst lakes. Within the frontiers of Poland, this type of lake is found in the Łęczna-Włodawa group of lakes. These lakes are as a rule located completely in chalk marl and are fed by water flowing through fissures; they are remarkable for purity of water and for considerable depths, the deepest being Lakes Piaseczno (38,0 m.), Białe (39.6 m.) and Krasne (33.0 m.).

Since a great part of the Łęczna-Włodawa lakes owe their existence to difficult subterranean drainage, ground water comes to the surface in depressions and forms ground water lakes — shallow, with marshy and inaccessible shores.

Finally, lakes in river valleys are a common phenomenon. The Vistula and the Warta alike flow through valleys abounding in lakes, larger or smaller. These are meander lakes, characterised by their curved shape. Such lake systems usually appear in their full extent after floods, when water remains for some time in the old, cut off, river beds. In some of them it remains all year round, as, for instance, in Lake Czerniaków in Warsaw. In view of the small size and the variability of lakes of this type they have, for the most part, been omitted from the Lake Catalogue.

HOW OLD ARE THE LAKE DISTRICT LANDSCAPES?

All Polish lakes are in a state of gradually disappearing. Biological processes, accumulation, outwash and, recently, irrigation work — all these factors are causing a steady reduction of lake areas.

Observing the contemporary rapid shrinkage of aquatic surfaces, it is frequently difficult to find the link between the origin of Polish lakes and the distant Glacial Period. The high proportion of lakes which have survived in all lake districts, and in particular the exceptional morphologic freshness of the hollow forms, are — to say the least — amazing. They can be explained only by the successive changes in the climatic environment of the last glaciation.

The climate of the last glaciation may be divided into three main periods: 1) early glaciation — the period of transgression of the ice; 2) the full glaciation — a protracted period of maximum extension of the ice sheet; 3) the late glaciation, of particular importance to the present discussion on the origin of lake district landscapes. During this period a notably warmer and damper climate caused the ice to retreat, moraines to form, the enclosure of blocks of dead ice, intensive action of thaw-waters, oscillation of the ice-sheet and renewed freezing.

In order to understand fully the origin of lake district landscapes and to determine their age, it is particularly important to consider the part played by dead ice blocks enclosed in accumulation masses. The melting of dead ice is connected with the postglacial thermal optimum, which took place some 4,300 years B. C. The origin of all kinds of small concave forms or of great lake channels is, it is true, connected with the Pleistocene climatic environment, but is was only the warm climate at the beginning of the Holocene which was the liberating factor.

The warm climate of the postglacial thermal optimum, following directly on the prolonged cold period, was a major morphogenetic factor. The melting of dead ice in boulder clay deposits, of ice preserving lake channels, of winter ice enclosed in sanders or lenticles or wedges of ground ice — all these contribute to a general rejuvenation of the postglacial land relief. Whole labyrinths of ice channel lakes and innumerable small basins made their appearance and were immediately filled with stagnant waters. As a result of intensified erosion, a great number of river sources affected the water catchments; the lakes either flowed out or changed into flow-through lakes and certain channels were turned into river valleys.

The melting of dead ice transformed and rejuvenated the postglacial relief. Hence, the freshness of lake district landscapes is to a large extent a secondary, relatively juvenile phenomenon of the postglacial age.

THE SOUTHERN LIMIT OF LAKE DISTRICTS

The border between the northern zone, characterised by a massed and compact appearance of lakes, and the southern zone, at present almost entirely devoid of lakes, may be called the southern limit of lake districts.

This southern limit is also a visible morphologic boundary of two different kinds of postglacial landscape. The landscapes in the lake district belt are clearly defined by a complex of extremely fresh forms, numerous hills, sharp, irregular declivities, ungraded rivers, numerous enclosed areas, and a large number of lakes. Glacial accumulation areas south of this line are represented by completely different sets of forms. In the forefield of the icecap, intensive forces were in action in periglacial climatic conditions, reducing and grading hilly forms and filling in hollow forms. The lake districts of previous glaciations disappeared in periglacial and interglacial climatic conditions. Only in certain places are any traces of them left in the form of peaty depressions. Hence the great morphologic differences and the scarcity of lakes in central and southern Poland.

The period of melting of dead ice blocks during the post-glacial thermal optimum was the same for all lake districts. The genetic uniformity of these territories is shown in the investigations by, among others, S. Majdanowski on the distribution and density of lake channels, and in particular in the investigations on the direction of the limit of lake channels in Poland and in the European Plain. It is also shown in the investigations by R. Galon which demonstrate the almost identical degree of duration or disappearance of lakes in all Polish lake districts.

The sudden disappearance of lake channels on the border of groupings, the almost complete destruction of lake forms in the southern zone, and the enormous morphological differences on the two sides of this line are proof of an important difference in age as between the two zones, equal at least to the duration of one interglacial. The southern limit of lake channels and grouped lake districts unquestionably divides the deposits of two different glaciations, and it therefore constitutes the index of the furthest southern extent of ice during the last Baltic glaciation. The glacial deposits between the Baltic and the limit of lakes belong to a single glaciation. Morphological elements of the marginal zone of the last glaciation *(Würm)* must be sought on the limit of the lake districts.

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THE PROBLEM OF THE LAST GLACIATION IN POLAND

1. INTRODUCTION

When studying the morainic landscape and deposits on the glaciated European plain, it is the last glaciation which arouses particular interest. Backed by an examination of the recent landscape forms and of glacial and subglacial deposits subjected to only slight destruction, the young morainic landscape, left comparatively little changed by the periglacial processes during the last glacial period or by the down cutting work of the Holocene stream waters, offers perfect an opportunity to attempt an exact reconstruction of the process of deglaciation, i.e. of the differentiation and subsequent disappearance of the Scandinavian ice-sheet, and at fixing some general rules concerning the geological and geomorphological sequences of the Scandinavian glaciation. The experience gained here becomes an invaluable asset, also met with on the remaining parts of glacial territory, when identifying forms destroyed in the course of the interglacial and periglacial periods, and deposits transformed by weathering and denudation processes. Thus a study of the area of the last glaciation is of essential significance, providing a key to the genesis of the landscape forms of the entire area covered by the Scandinavian ice-sheet.

From a stratigraphic point of view, the last glaciation which occured on Polish territory is represented by a group of morainic clay layers with interspacing subglacial sand deposits in the form of sand and gravel, and with ice-dammed lake deposits in the form of varved silt and clay. There are also some interstadial sediments. As a result of a varying accumulative and exarative effect of the ice-sheet, the number of moraine layers is variable, while the thickness of the entire complex of last-glaciation deposits, undoubtedly not less than some 20—40 m., remains as yet not exactly known. This latter circumstance is caused by the difficulty of fixing the lower limit of those sediments and distinguishing them from similar ones of an older glaciation. In only a few places (Rusinowo near Świebodzin, Śmielin near Nakło, the environs of Poznań) has it been possible to discover under morainic sediments of the last glaciation, plant fossils of the last interglacial. The majority of interglacial profiles containing plant fossils of that period are to be found outside the territory of the last glaciation and are covered only by some extraglacial river deposits (e. g., Kalisz or Żoliborz) or with loess (Trzebnica). As has already been demonstrated by A. K a l n i e t *(16)*, such extraglacial interglacial sites in the form of peaty, sand-covered lake basins, are very abundant. According to some investigators, the interglacial is represented by the well-known Eem deposits, appearing on the lower Vistula territories in the form of intermorainic sediments. The fact, however, that such deposits seem to occur on several levels (a secondary layer, perhaps?), undermines to a considerable extent their stratigraphic position.

For these reasons, last glaciation sediments constitute a particularly interesting object of geomorphological studies. The desire to know, in the light of recent landscape forms, the exact process of glaciation and of its gradual retreat, is, however, not the only consideration which makes the landforms the chief criterion of reference in the study of such questions; also involved are such circumstances as the scantiness of the existing paleontological data capable of explaining the problem of the maximum extent of the last glaciation and of the number and the limits of its respective recession and oscillation stages, or the stratigraphic variability of glacial deposits.

The most striking progress in the geomorphology of the territory of the last glaciation in Poland has been made since the Second World War. What first aroused particular interest in the territory in question was the preparation of a General Geological Map of Poland — scale 1 : 300,000 — in connection with which numerous detailed studies have been undertaken dealing with particular end-moraines, outwashes, valley terraces, etc. But of still greater importance to the study of the landforms of the territory of the last glaciation is the geomorphological mapping (scale 1 : 25,000 or 1 : 50,000), started in 1950 and supported by a set of special studies of either a monographic or of a general review character.

The cartographic and descriptive material available, collected from articles and studies by various authors, furnishes a sufficient basis for a rough sketch of a synthetic picture of the last glaciation on the territory of Poland. A morphological map, compiled by L. Roszkówna, is included here as a supplement.

2. THE SOUTHERN LIMIT OF THE LAST GLACIATION IN POLAND

The problem of the southern limit of the last glaciation has a history of its own reaching back to the beginning of the present century. The proper basis for a solution was reached only when the presence of lakes, a typical characteristics of the territory of the last glaciation, was taken as criterion of reference. First to take note of the fact was Tietze, and the discovery was practically applied by (among others) P. Woldstedt, in his numerous papers on glaciation limits on the territory of the German and Polish Plain.

In recent years, the question has been taken up by S. Majdanowski (*26, 27*), who has reached the conclusion that it is not so much the lakes as the subglacial lake channels, superior to the lakes themselves, that provide the best morphological criterion for distinguishing old landscapes from young. They constitute a perfect expression of the dynamics which shaped the landscape; "while the existence of genetic links with the belts of end-moraines and outwashes facilitates the interpretation of the last-glaciation limit in the proper sence of a marginal zone of inland ice" (27, p. 111). In its main outline, the southern limit of the last glaciation as fixed by Majdanowski confirms that fixed by Woldstedt. However, the former has brought to light some hitherto neglected details in that limit, such as, for example, the interlobate curve of the ice margin in the vicinity of Września which constituted the initial boundary between the Vistula and Odra lobes.

The discussion on the limit of the last glaciation is, however, still going on. In Poland, it is mainly carried on by geologists and paleobotanists. The fact of the occurrence south of the boundary of lakes characteristic of the territory of the last glaciation, of numerous flat closed depressions (kettles), in some cases going even to what is called the Warta Stage, has already been noticed by Wunderlich *(46)*. Jessen and Milthers *(15)* consider these depressions as lake basins formed during the preceding glaciation and filled with peat and soliflual sand. The distribution in Poland of such lakes has been given by A. Kalniet *(16)*. In view of the presence of numerous closed depressions (kettles) south of the last-glaciation area, Woldstedt had originally regarded the Warta Stage as a separate glaciation, while R. Grahmann *(10)* thought it to be the extreme limit of the last glaciation.

The question of the relation of the Warta Stage to the last glaciation calls for comment. There are three different conceptions:

1. that the last glaciation limit follows the southern boundary of lakes or lake valleys, and the Warta Stage constitutes a final phase of the penultimate glaciation;

2. that the Warta Stage represents the farthest extent of the last glaciation;

3. that the Warta Stage constitutes a separate glaciation.

Most authors support the first conception. B. Halicki *(11)*, although he has identified on Poland's territory a considerable number of glaciations, has seen no reason for accepting a separate glaciation of the Warta. He thinks the Warta Stage a recession stage of the Middle Polish glaciation. Thus, the Warta Stage is divided from the maximum stage of the penultimate glaciation by an interstadial, and from the last glaciation by an interglacial. That is also the view of Woldstedt (45), who also adds that that stage must have been of a slightly different character.

W. Szafer *(40)*, on the other hand, who prepared a synthesis of the Pleistocene in Poland, based upon a study of fossil flora from 266 localities in the country, has adopted a different attitude, more in line with that of the supporters of the second conception. The object of his considerations was the problem of the prehistorically important Aurignacian interstadial. In his opinion, that interstadial, characterized by a cool climate, lacked phases that might prove an advanced recession of inland ice. According to Szafer, the Aurignacian interstadial divided the Warta Stage, regarded here as the oldest stage of the last glaciation, from the Brandenburg Stage. Recently, a Soviet investigator also, A. N. Mazarovitch *(28)*, has come to the conclusion that the Fläming and Warta Stage end-moraines should be regarded as corresponding to the Kalinin-Orsha-Mińsk moraines, which constitute beyond any doubt the oldest stage of the last glaciation. The German scientist, J. H e s e m a n n[1] expresses a similar view which he bases on the similarity between the petrographic composition of the end-moraines of the Brandenburg and the Warta Stages (on Brandenburg territory). In place of the South-Swedish rock, typical of the penultimate glaciation, the Warta Stage moraines contain a good intermixture of East-Fennoscandic, Middle Swedish, and South-Swedish matter. However, as W o l d s t e d t rightly points out *(45,* p. 359), that petrographic similarity can only prove the existence of a similarity between the ice-sheet and the direction it followed during the Warta Stage, and during the last glaciation; it does not constitute proof of the Warta Stage having actually belonged to that glaciation. E. R ü h l e *(39)* comes to the conclusion, in view of all the literature dealing with the subject of the stratigraphy of the Pleistocene in Poland written since the war, that the stratigraphic situation of the Warta Stage has not yet been finally solved. He nevertheless supposes that stage to belong to the penultimate glaciation.

The third conception has, in more recent times, found a supporter in M i l t h e r s *(29),* who, basing his conclusions on the southern limit of the brown Baltic porphyry, distinguished a separate Warta Glaciation on the territory of Poland and Germany, older than the Vistula Glaciation (= Würm), and younger than the Saale Glaciation (= Mindel). On the territory of Poland the boundary of that porphyry does not, however, coincide either with the Warta Stage moraines or with the Middle Polish Glaciation moraines, but runs mostly between the two, and thus has no morphological foundation *(9).*

Let us now review the problem of the age of the Warta Stage in the light of geomorphological criteria. It was undoubtedly the morphological character of the Warta Stage end-moraines that was decisive in provoking the attempts to include that stage in the last glaciation.

The moraines there form a somewhat continuous belt with a distinct landscape of end-moraines. The morphological significance of such moraines is enhanced by their coinciding with elevations of the substratum on which they have been deposited (Kocie Góry, Wzgórza Ostrzeszowskie). Both the end-moraines and the substratum elevations evince numerous glacitectonic perturbances. It must not be forgotten also, that the area of the Warta Stage contains many filled-in former-lake basins (A. K a l n i e t.) Only in a very few cases, particularly east of the Vistula, do those basins overstep the limit of the stage in question. At the same time, however, the moraine hills clearly possess somewhat gentle, denudated slopes, best preserved in the watersheds. Numerous studies and a good deal of research work, conducted in the Łódź district by J. D y l i k *(2),* show that the Warta Stage end-moraines were destroyed in the conditions of the periglacial climate during the last glaciation. Denudation lead to a considerable softening of contours, and all the hill forms in the landscape were lowered by up to 10 m.; all the depressions also became filled in. Any elevations preserved in that levelled landscape are mostly of a residual character, with here and there steepness of

[1] Cf. the Report by J. M o j s k i *(30).*

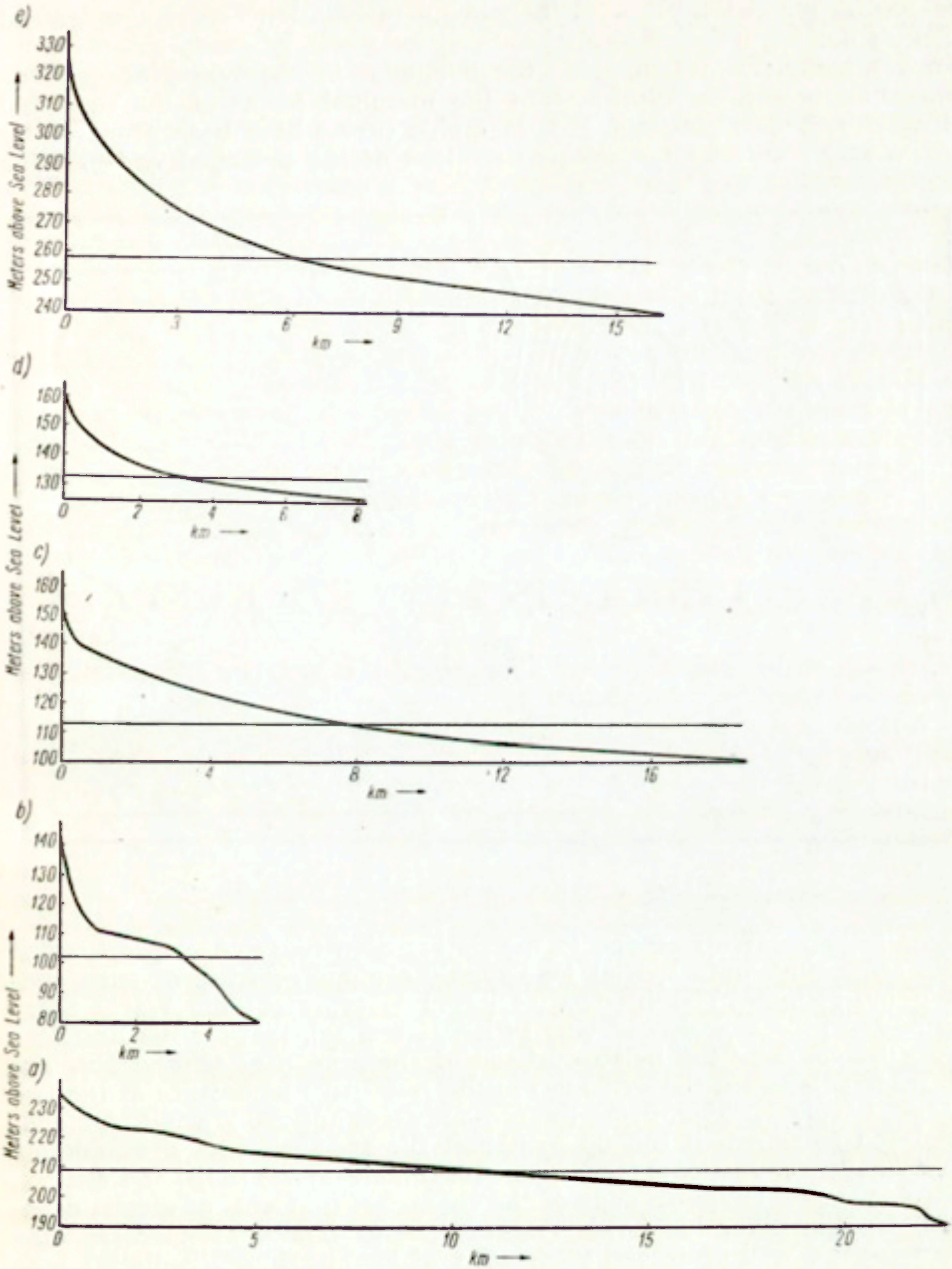

Fig. 1. Hypsographic curves of some selected end-moraines of the last glaciation and of the Warta Stage

(a) Warta Stage, (b) Brandenburg Stage, (c) Frankfurt Stage, (d) Foreland of the Pomeranian Stage (near Więcbork), (e) Pomeranian. Cf. the topographic contour maps corresponding to each of the respective hypsographic curves (Figs. 2a, b, c, d, e) slopes, originated by erosion, suggesting the existence of young glacial landscape.

With a view to comparing the dynamics in the Warta Stage end-moraines landscape with that of the marginal forms of the principal stages of the last glaciation, hypsographic curves have been prepared by A. Waskowska[2] for selected sections of the principal end-moraine

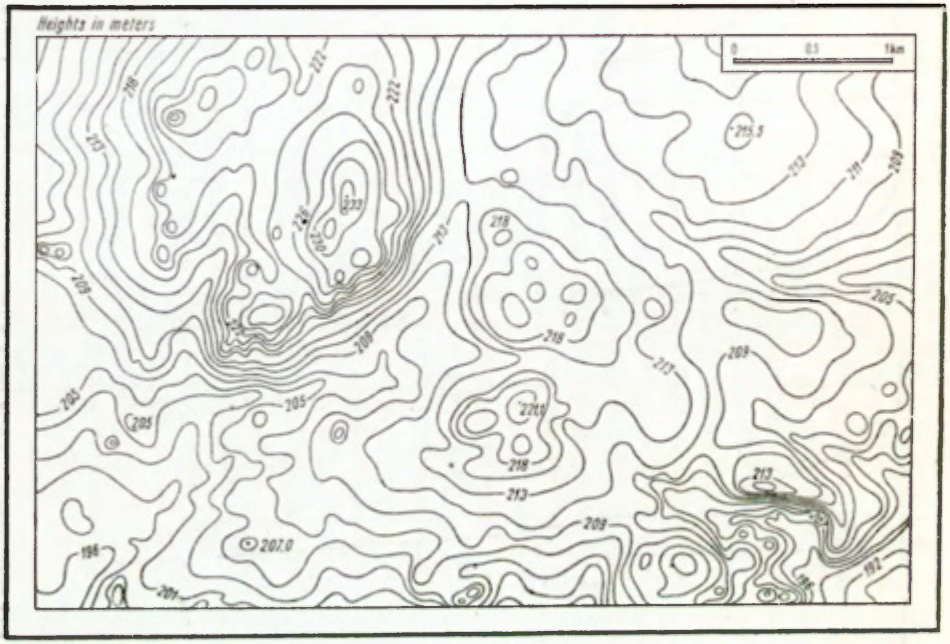

Fig. 2a. End-moraine landscape of the Warta Stage

belts from the Warta Stage to the Pomeranian Stage. Also prepared at the same time were special topographic contour sketches of such end-moraine sections. The fragment selected to represent the Warta Stage came from the vicinity of Tuszyn (figs. la and 2a), that for the Brandenburg Stage, from the neighbourhood of Osieczna (figs 1b and 2b). The difference between the dynamics in the respective landscapes of the two stages is very striking. From the contour sketch of the Warta Stage end-moraine fragment, it can be seen that the area presents a completely erosionally-denudational landscape with flat elevations (hills) and distinct, regular slopes, and with none of the characteristic forms of glacial deposits. On the other hand, the end-moraine at Grodzisko near Osieczna represents a well-preserved topography of ice margin accumulation with numerous small hills and unequal depressions (kettles). The double fall of the hypsographic curve is the outcome of that end-moraine's being situated on the edge of a moraine plateau over a large former-lake depression of erosional (fluvioglacial) origin. A fundamental morphological

[2] M. A. Degree thesis, in MS, Toruń. 1955.

difference between the Warta and the Brandenburg stages is also clear from the diagrams prepared in 1938 by R. G a l o n *(3)* illustrating the number of closed depressions lying south of the Baltic Sea down to and including the Warta Stage. The diagrams fully confirm that the Warta Stage was separate from the last glaciation; and the demonstrated morphological contrast between the Warta and the Brandenburg Stages has been explained only in recent years, with the discovery of the characte-

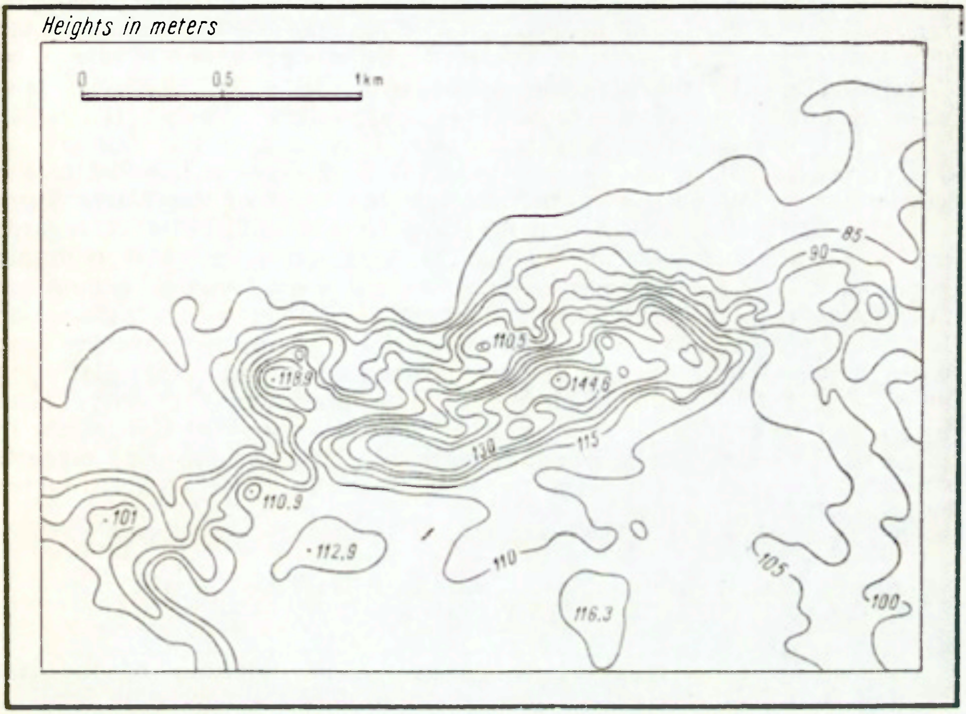

Fig. 2b. End-moraine of the Brandenburg Stage

ristic forms of periglacial sculpture, common on territories south of the Brandenburg Stage, i. e. of the farthest limit of the last glaciation during which a separate periglacial sculpture took shape adjacent to the ice-sheet.

Let us now in turn give some consideration to a glaciation established by B. H a l i c k i *(12)*, the so-called North-Polish or North-Polesie glaciation. Its deposits and forms have been preserved on the surface only in north-east Poland, because in the other parts, the author explains, the deposits have become covered up by the sediments of the last glaciation. The problem is of great importance to the present considerations, since in H a l i c k i' s scheme of six glaciations these moraines are treated as younger than the Warta Stage, which he places within the Middle-Polish glaciation. Though originally inclined to identify the North-Polish glaciation with the Warta Stage, placing its limit (like W o l d s t e d t) towards Podlasie and Middle Poland, H a l i c k i has now parallelled the North-Polesie (or, as it is now called, North-Polish) glaciation with the Moscow Stage which is regarded by N. Sokołow as a separate, penultimate glaciation, and has drawn its boundary north from the Warta Stage (and from the Podlasie Stage, as conceived by B. Zaborski) in the direction of the upper Narew and Białystok. The Warta Stage is concealed under the deposits of the North-Polish glaciation, the course of which further westward is unknown. Halicki does not think it impossible that that glaciation may take in the moraines of Czerwony Bór, Mława, and the Ciechanów area. Further west, he maintains, the North-Polesie glaciation sediments are hidden under the deposists of the last glaciation. The North-Polesie glaciation is said to be "characterized by disappearing lakes and relics of subglacial lake channels, numerous closed depressions and valley eskers" *(12,* p. 98). Thus, it is a relatively young landscape. This is also the opinion of J. Nowak *(32),* in her description of the landscapes of the Pleistocene glaciations in Poland. She also finds that the areas of the Warta Stage and the North-Polish glaciation manifest certain similarities as regards landscape, but differ in the degree of weathering of their morainic deposits. S. Pietkiewicz[3], who bases his views on exhaustive investigations, corroborates the description of the North-Polish glaciation landscape presented by Halicki and Nowak, but — agreeing here with the views professed by Soviet authors — he defines that glaciation as a stage of the Middle Polish (penultimate) glaciation. Certainly, it can in no way be considered as a phase of the Baltic (or last) Glaciation. In place of the term "North-Polish glaciation", Pietkiewicz suggests "North-East stage", in view of the extent and the direction from which the ice -sheet proceeded.

3. GENERAL MORPHOLOGICAL CHARACTERISTICS OF THE LAST GLACIATION

Knowledge concerning the morphology of the territory of the last glaciation in Poland is not uniform, and therefore the degree of detail in the map included here varies. Nevertheless, the cartographic picture given permits of a fairly exact reconstruction — far more exact than has ever been possible heretofore — of the course followed by the recession or oscillation phases, in the light of clearly-marked belts of end-moraines.

The area covered by the last glaciation in Poland grows very narrow towards the east, making a zone some 300 km. wide to the west of the Vistula and only 50 to 70 km. on Mazury territory. In view of the fact that the territory of the Mazurian Lake District includes all the stages and phases of the ice-sheet's retreat appearing over the wide area west of the Vistula on the territory of Pomerania and Wielkopolska, it may well be imagined how compressed are the end-moraine belts in the Mazurian Lake District and how highly differentiated its landscape must be.

On reaching its maximum extent, the last glaciation dwindled gradually. The successive recession stages, combined with inland-ice oscillations, left their mark in the shape of major end-moraine belts.

[3] Information received from the author by letter dated December 1955.

P. Woldstedt earlier identified (1929) three principal stages of that glaciation, which he called the Brandenburg, the Frankfurt (or Poznań), and the Pomeranian Stages. Later (1931), he had added the Chodzież Phase ("Kolmarer Staffel"), just behind the Frankfurt one, and recently (1950), he has been inclined to think that the end-moraines from Tuchola, across Wąbrzeźno, Iława, Szczytno, and Ełk, represent an initial (transgressive) phase of the Pomeranian Stage.

The question now arises, whether there be any stratigraphic and plant foundation to justify such a division of the last glaciation, i. e., whether there do exist any suitable interstadial deposits, and, above all, whether there does exist a Mazurian Interstadial, dividing the Frankfurt (or Poznań) Stage from the Pomeranian Stage. Organogenic deposits from the last interglacial have been discovered by K. Bitner *(1)* near Mielnik on the river Bug; they were covered up by silty sediments of two cooler phases which probably correspond to two stages of the last glaciation. More recent research results suggest that at least to some extent, the Mazurian Interstadial deposits come from the late glaciation. Certainly — and this is also corroborated by Woldstedt — the stratigraphic situation of such sediments is obscure. Thus, stratigraphic criteria so far fail to explain with absolute certainty the question of the number of stages in the last glaciation.

4. DESCRIPTION OF THE STAGES OF THE LAST GLACIATION

A. The Brandenburg (or Leszno) Stage, which marked the maximum limit of the last glaciation, is representative of a moraine belt stretching across Zielona Góra, Leszno, Września, and Gostynin. Moraine hills near Konin, Koło, and Turek belong to an older glaciation. The belt, generally rather well defined, makes many turnings on its course, pushing out to the south up the Nysa valley or the Obra basin, and coming to an end over the Zielona Góra hills. A deep gulf occurs across the course of the Brandenburg Stage boundary near Września, discovered by S. Majdanowski *(26)* and formed as a result of the contact of the Odra lobe with the Vistula lobe. Near the Vistula valley, end-moraines of that stage disappear. It is a matter of doubt whether they were destroyed or covered up in the course of the oscillation of the ice-sheet during the Frankfurt (Poznań) Stage. Marginal forms during the Brandenburg Stage, i. e. of the maximum limit of the last glaciation, occur only far east of the Vistula valley, on the territory of the great Kurpie outwash, from under which it shows here and there. Numerous subglacial lake channels which appear in the midst of the outwash sands, there mark the limit of the last glaciation.

Brandenburg Stage end-moraines present a landscape which is fresh and typical of glacial deposits, comparatively slight transformed by later erosion and denudation processes (see figs. 1b and 2b).

B. The Frankfurt (or Poznań) Stage is represented above all by the same belt of end-moraines as passes across Poznań, Gniezno, Gostynin, to the Vistula valley, and east of the Vistula, past Lipno, Szczytno, to the south banks of lake Śniardwy. The stage is of an oscillative and even a transgressive character. This is evidenced not only by the large ice lobe which protruded from up the present Vistula valley [4], but also by the number of smaller lobes, like the Odra, the Obra, the Mosina, and Września lobes, preserved in semicycles of end-moraines. W. N e c h a y *(31)* assumed the end-moraines of Ziemia Dobrzyńska (east of the Vistula valley) to be a consequence of a great inland-ice oscillation (the "Dobrzyń oscillation"). The forms taken by the Frankfurt Stage are common and typical on the territory of Poland. There are many closed depressions, indicating the young age of the landscape. The example herewith of the

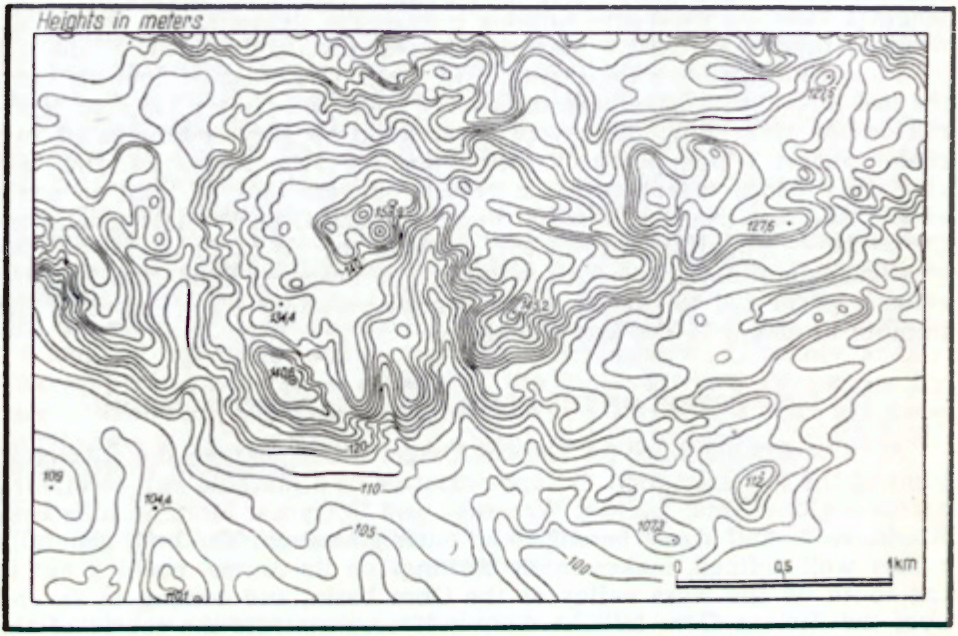

Fig. 2c. End-moraine of the Frankfurt (Poznań) Stage

landscape of that stage from the Poznań area, Morawska Góra (figs 1c, 2c), is not fully representative of the landscape characteristic of that stage, owing to the close vicinity of the Warta valley, which must undoubtedly have hastened its denudational and erosional transformation.

In the light of morphological criteria, the Frankfurt Stage must certainly have been an important stage in the last glaciation, and it is hardly possible to agree with those German investigator who, as J. E. M o j s k i reports *(30)*, questions whether the importance of the Frankfurt Stage is on an equality with the other stages. Though it is true that there is so far no stratigraphic proof or the existence of an interstadial, between the Brandenburg and the Frankfurt Stages, nevertheless the transgressive character of that stage, evidenced by the presence of numerous moraine ridges, especially the large Vistula lobe, and by the strong

[4] Excluded from the present considerations is the problem of valley glaciation. advanced by J. L e w i ń s k i *(23)*, S. L e n c e w i c z *(22)*.

development, both horizontal and perpendicular, of the end-moraine, indicates a considerable degree of independence of the Frankfurt Stage.

C. In between the main belts of end-moraines of the Frankfurt and the Pomeranian Stages, there appear numerous smaller or larger end-moraine belts, representing the phases of the retreat of the ice-sheet between the Odra lobe and the Vistula lobe of the Pomeranian Stage. The question now arises whether the more important of the marginal zones correspond to certain greater phases of the retreat of the ice-sheet, and thus show a similar character to that of the stages described above. This problem is analysed by P. Woldstedt *(45)*, St. Pietkiewicz and R. Galon *(6)*. The cartographic picture included herewith, showing the course of the marginal zones is more detailed for the area north of the Noteć ice-marginal streamway (Urstromtal) than for that south of it. The main morphogenetic traits of the whole of the interstadial area can, nevertheless, be gathered from the picture.

Behind the principal zone of end-moraines of the Frankfurt Stage south of the Noteć ice-marginal streamway, there appear several belts of end-moraines having an oblique or lobal course. The most important, that passing from the mouth of the Gwda to the Noteć in a south-easterly direction, has been defined by P. Woldstedt *(43*, p. 61), as the Chodzież Stage ("Kolmarer Stadium"). These various marginal forms, which in some places assume the character of creased moraines, are matched on the east bank of the Vistula valley, near Lipno, by numerous small belts of end-moraines, mostly lobal in character. The marginal zones mentioned above are connected on one side with the wide Vistula lobe of the Frankfurt Stage, and on the other constitute the margin round the great Toruń-Bydgoszcz basin which facilitated the protrusion of inland ice there in the form of a wide lobe. P. Woldstedt regards the Chodzież Stage as the beginning of the great Vistula lobe of the Pomeranian Stage. The ice-sheet uniform frontill then, was gradually divided to form the Vistula and the Odra lobes. To judge by the curves formed here by the moraine ridges, interlobal contact took place near Wałcz. A similar belt of end-moraines, identified by B. Krygowski[5] and named by him, the North-Poznań end-moraine, runs across Gorzów — Czarnków — Gniezno.

I do not imagine that this end-moraine belt has the character of a stage in the full sense of the word. I am rather inclined to regard it simply as a major recession and oscillation phase subsequent to the Frankfurt Stage. Nor does it seem likely to me that the North-Poznań moraine (or, the Chodzież Stage) mark the beginning of the great Vistula lobe of the Pomeranian Stage. Moreover, it can also be seen from the attached map that the further recession phases, especially those in the vicinity and to the north of the Drwęca and Noteć ice-marginal streamways, have most commonly a latitudinal direction. Hence, the oblique position of the Chodzież Phase would be due to certain local causes (the Toruń-Bydgoszcz basin, and possibly the Vistula valley near Włocławek);

[5] In an explanation attached to his MS map of the morphogenesis of the Wielkopolska district (1955).

as soon as such causes disappear, as is the case further north, the marginal zones of inland ice resume their latitudinal direction.

Particularly interesting are the marginal zones shaped in the form of two rows of high isolated hills, located along both banks of the Noteć "Urstromtal", so close to it in places, that the slope of the moraine hill merges into that of the valley, giving in effect uncommonly large relative heights (e. g. Dębowa Góra, 143 m.). The elevations contain a core of Pliocene silt, with some traces of glacial dislocation; on the outside, they are made up of boulder clay and sand. So far, genesis of the elevations remains obscure. Owing to their height they have been considerably affected — particularly these situated immediately over the Noteć ice-marginal streamway — by denudational and erosional processes, and

Fig. 2d. End-moraine from the neighbourhood of Więcbork

transformed into hills of an erosional sculpture. However the original glacial character is beyond doubt. It seams most probable that during the oscillation of the ice-sheet there must have been here some elevations of the substratum, which became intensified owing to the pressure of the ice-sheet, dislocated, and then covered over with glacial and fluvioglacial sediments. Detailed investigations now being pursued seem to confirm this thesis.

Northward from here, both to the west and east of the lower Vistula valley, appear numerous marginal zones running with some slight lobal curves, mostly in a latitudinal direction. This is perfectly ilustrated on the attached geomorphological map. Particularly distinct belts of end-moraines have been found between the Vistula and the Brda, and in many cases the data obtained confirm the correctness of the observations presented by G. Maas in 1900 *(25)* [6]. R. Galon *(6)* has discovered, on the area between the Noteć ice-marginal streamway and the Pomeranian Stage, the presence of some 26 marginal zones, spaced at an average of 3.5 km. from one another. Also, west of the lower Vistula valley and north of the Drwęca valley, many end-moraine belts have been traced, broken here and there by forms left behind by dead ice *(37, 42)*.

The question now arises whether there does not exist, somewhere among those marginal zones which stretch between the Drwęca and Noteć ice-marginal streamways and the Pomeranian Stage, a zone of stadial significance. The question is real, since the investigations of the past decade have revealed the existence there, especially in the environs of Więcbork, of some hitherto unknown, mighty end-moraines with a real height of up to 40 m. *(5)*. They also have their equivalent cast of the Vistula valley, in the impressive end-moraines of the Wąbrzeźno area.

The topographic contour sketch and hypsographic curve of the moraine hill near Więcbork (shown at figs. 1d and 2d) illustrates perfectly the morphological character of that form, and goes far to prove the recent nature of the glacial sculpture there. S. Pietkiewicz mentions a Krajna Stage, while Woldstedt *(45*, p. 364) is inclined to assume that the Tuchola — Wąbrzeźno — Iława — Szczytno — Ełk indicates the initial (oscillative) phase of the Pomeranian Stage. Certainly, the marginal zone in question is remarkable for its outstanding end-moraine landscape which does not differ from the end-moraines of the Pomeranian Stage (cf. figs. 1e and 2e); all the same there are no grounds for considering those moraines as constituting a separate stage or even a projecting phase of the Pomeranian Stage. One can speak rather of a northward intensification of the sculpture of glacial landscape, of its increasing freshness; i.e. a longer period of recession must be assumed, lasting until the Pomeranian Stage and interrupted by numerous phases of retreat or even by slight oscillations (e. g. near lake Charzykowo, north of Chojnice), accompanied by processes of melting of stagnant ice and the shaping of the so-called dead-ice landscape (e. g. near Wąbrzeźno).

D. The Pomeranian Stage has little, morphologically to distinguish it from the preceding recession phases. As demonstrated by R. Galon *(6)*, the relative heights of moraine hills are similar, and the greater absolute height of the Pomeranian Stage moraines is a result of the greater absolute height of the moraine plain which rises to its maximum height (over 200 m.) on the territory of the Pomeranian Stage. It has been demonstrated also that the main zone of end-moraines of the Pomeranian Stage comprises numerous closely placed moraine belts; that means that the Pomeranian Stage is made up of a number of recession or oscillation phases, similar to but more concentrated than those noted on the foreland. Are we, therefore, justified in regarding the Pomeranian Stage moraines as equivalent to those noted on the foreland?

The criterion for distinguishing the Pomeranian Stage from other, older forms, is their morphological contact. Belts of end-moraines on the foreland of the Pomeranian Stage run as a rule in a latitudinal direction,

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[6] F. Wierciszewski. M. A. Degree thesis, in MS, Toruń 1955.

whereas the end-moraines of the Pomeranian Stage, protruding semicircularly on to the territory of the older moraines, cut them at various places (cf. map.). Undoubtedly, what is being dealt with here is a decisive oscillation of the ice-sheet, with a return of glaciation which, by way of the Pomeranian Stage, again covered territories already freed from ice. In the process, the ice-sheet damaged or destroyed the end-moraines formerly created, which have been preserved only on the space between the lobes, often showing through the covering outwash. Following

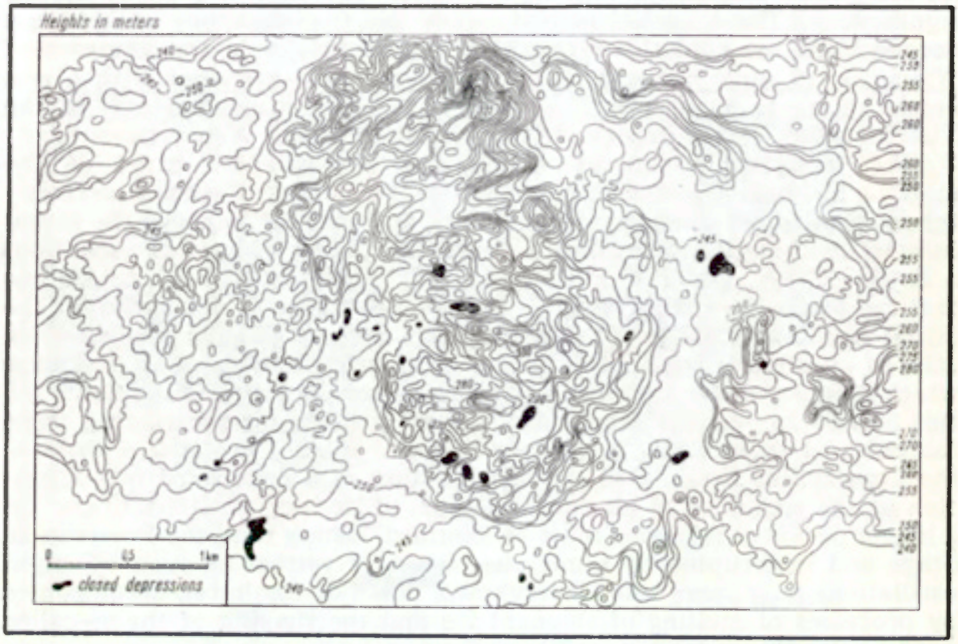

Fig. 2e. End-moraine of the Pomerania Stage

the same latitudinal direction, there run end-moraines differing directionally from moraines of the older phases, the direction being in turn adapted to the shape of glacial lobes *(6,* p. 56—57).

This directional divergence as between the end-moraines of the Pomeranian Stage and these of the foreland of that stage, may have been the result of tectonic movements which caused the differentiation of the subglacial surface on the territory situated near the Baltic, particularly over the lower Odra and lower Vistula, and also the rising of those great lobes, so characteristic of the Pomeranian Stage. Thus, these tectonic movements must have taken place during the oscillation of the ice-sheet at the beginning of the Pomeranian Stage or in the interstadial just preceding it (cf. 6, p. 67).

In accordance with the above views, the farthest limit of the Pomeranian Stage on the territory of Pomerania is determined by the end-moraines of the Vistula and Odra lobes. In a few places, they are preceded, at a rather short distance, by oscillation moraines. In no way, however, did not oscillation of the ice-sheet during the Pomeranian Stage extend (as P. W o l d s t e d t *(45)* asserts) as far as the moraines of Więcbork — Tuchola — Wąbrzeźno. As already explained, those moraines are older than the Pomeranian Stage. Moreover, they coincide to a considerable extent with the area between the Vistula and Odra lobes.

The limits of the Pomeranian Stage are particularly clear along the compact moraines of the Odra lobe. This constitutes the farthest reach of that stage on the Middle European Plain. Eastward, the Odra lobe passes into a zone of end-moraines parallel to the shore and including the highest culminations of the area. The zone comprises numerous small lobes. The course followed by the marginal forms indicates that the ice-sheet must have here done much mobile. At the acute angle between the lobes, to which there corresponded and interstitial zone in the ice-sheet, with a high activity of the thaw waters on the foreland, the Pomeranian belt of end-moraines makes contact with the Vistula lobe. The latter is much smaller than then Odra lobe, and not so clear-cut: it is therefore not always easy to distinguish it from the older morainic forms. That task has been performed by L. R o s z k ó w n a *(37)* who established, among other things, the boundary of the Vistula lobe on the east bank of the lower Vistula valley. Investigations by that author *(36)* and by J. K o n d r a c k i *(19)* have made it possible to fix the exact limits of the Pomeranian Stage east of the lower Vistula. The sharp interlobal boundary divides the Vistula lobe near Morąg from the well-defined Łyna (Alle) lobe which, in turn, makes contact with the wide but short Mazurian lobe extending to the north end of lake Śniardwy. The next lobe begins near Suwałki. Thus, the Pomeranian Stage, as a transgression stage, occupies on Mazurian territory the greater part of the total glacial area there. The preceding stages are represented only by two end-moraine belts, the outside of which most frequently disappears under outwash sand. Certainly, the end-moraines of the environs of Nidzica and Szczytno belong, according to the results obtained by J. K o n d r a c k i *(19)*, to the Frankfurt Stage, and not, as P. W o l d s t e d t would have it (45, p. 260), to the initial phase of the Pomeranian Stage.

Pomeranian Stage end-moraines usually possess the typical form of ridges, often occurring in several rows and full of closed depressions varying in size (see figs. le and 2e). Besides these typical forms, we find marginal zones of a general type, morphologically less clear. All the marginal forms represent either the accumulation type of moraine, or the thrust type. Almost everywhere, end-moraines of the Pomeranian Stage pass into outwash plains, particularly developed on the interlobate areas.

At the rear of the main belt of end-moraines or of a corresponding marginal zone, representing the maximum limit of the Pomeranian Stage, there appear numerous end-moraines corresponding to the minor phases of retreat during the stage itself or during the recession of the ice-sheet to the site of the Baltic. The interior of the Odra lobe presents a remarkable poverty as regards marginal deposits. More outstanding are the drumlins there occuring. Owing to a lack of detailed investigations on the territory, it is not yet possible to reconstruct the exact course of the recession process of the Odra lobe. On the territory of Pomerania there are to be noted at least some three or four major stages of retreat, marked by distinct end-moraine belts. On the territory of the Vistula lobe, there are many end-moraines, in places forming semi-circular arrangements. Twelve phases of retreat, connected with oscillations, have been identified by L. Roszkówna on the east side of the Vistula valley *(36)*. The recession of that lobe occurred by stages and lasted for a relatively long time. Many minor phases of retreat can be noted inside the Łyna lobe. The main end-moraine zone of the Mazurian lobe north of lake Śniardwy comprises (according to J. Kondracki, 19) two or three marginal belts. Further north, there are central depressions, now occupied by lakes and separated from one another by end-moraine belts. On the whole, some eight to ten major phases of retreat comprising up to 20—30 minor stops, can be detected on the territory of the great Mazurian lakes. The last and youngest end-moraines appear on the coast of Pomerania, in the vicinity of lake Gardno. These belong to the Goti-glacial. Further moraine belts can be traced on the Baltic bottom *(14)*.

The course followed by the last few phases of retreat of inland ice in Pomerania suggest that, with many intervals, the ice-sheet retreated along what is now the Baltic coast, with a simultaneous corresponding shrinking of the lobes.

5. FINAL REMARKS

A picture is here presented of the course of the last glaciation on the territory of Poland from the moment of its maximum extent. This is supplemented by a detailed map tracing the belts of end-moraines of that glaciation and of some older stages. Both the discussion and the map are primarily based on detailed post-war research work in the field. The results of these investigations suggest a new and fuller rendering of the various problems related to the question of the last glaciation in Poland, such as: the problem of the minor phases of retreat, of some local oscillations of the ice-sheet, the rising of numerous small lobes, or the question of the relation of the Warta Stage to the last glaciation, or of the independence of the Pomeranian Stage.

Particular attention is here paid to the possibility of a reconstruction, in the light of an analysis of the minor recession or oscillation phases, of the course followed by the last glaciation. Hitherto, works dealing with that subject have usually interpreted the successive stages of the last glaciation chiefly on the basis of the course followed by the extreme end-moraine of a given stage, without much thought for the smaller end-moraine belts filling in the space between the two stadial moraines. Now, it has been demonstrated that only an analysis of those numerous small deposits makes possible a proper morphogenetic estimate of the extreme stadial end-moraines, and a full reconstruction of the greatly differentiated process of deglaciation on the territory of Poland.

These considerations stress the geomorphological role of moraine belts, omitting the problem of the deposits left by dead ice which occupy a considerable area of the territory in question. Omitted, too, have been such question as drainage, outwashes, or ice-marginal streamways, and their relation to the successive stages and phases of retreat.

Research work on the course followed by marginal zones on the territory of Poland is in progress. The ultimate object of that work is to establish the absolute age of the successive stages of deglaciation on the territory of Poland, and the subordination of those phases to the rhytmical variations of the Pleistocene climate.

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SLOPE RESEARCH STUDIES IN POLAND

Major studies on the evolution of slope surfaces were initiated in Poland in connection with problems of the asymmetry of valleys and ridges in the mountain and highland areas of Poland. Papers by E. Romer *(20)* and J. Smoleński *(22)* were among the first to be published on this subject at the beginning of the century, while those commented upon by J. E. Mojski *(14)* and Ł. Pierzchałko *(16)* appeared in more recent times.

Morphometric investigation work on sloping land surfaces has always to some extent attracted Polish scientists. It sought to determine what is called average slope inclination, i. e. the establishment by means of topographic maps of the fall gradient of a hypothetical surface constituting, as it were, the average slope of the area investigated. Some sections of the Carpathian Mts., as well as of Silesia and the Lublin Plateau have been thus mapped. Papers by J. Flis *(7)*, J. Szaflarski *(23)*, and B. Zaborski *(27)* are the most noteworthy in Polish literature dealing with the subject. These papers, however, though useful in geographical regionalization of the country, are of no great importance as regards knowledge of the true morphology of the slopes. J. Czyżewski's work *(2)* dealing with slope planation also falls within this group of literature.

Another group comprises publications on slope geology concerned above all with slide and creep problems. The Carpathian Mts., made up of Flysch deposits with marked susceptibility to gravitation forces, constitute a well known slide area. Works by L. Sawicki *(21)*, H. Teisseyre *(26)* and B. Świderski *(25)* are the most noteworthy among those published on the slide problem in the Carpathian Mts. Yet these works do not clarify the Carpathian slope problem as concerning age or evolution. The authors regard the slides there as regional phenomena resulting from the geology of that part of the slope where the slide occurs. They do not, however, explain the significance of the sliding processes in the formation of the slope as a whole.

The post-war years have witnessed in Poland an increasing interest in slope problems, such as those connected with slope formation and erosion processes. Thus, geomorphic studies, which have attracted so much attention of geographers in many countries, are by no means unknown to Polish geographers.

Three factors may be cited as having contributed to the development of interest in slope investigation in Poland.

1. It is now commonly believed that the slope constitutes the cardinal relief feature and that its importance in morphological theories has hitherto been underrated. Investigation studies now proceeding and looked forward to for the near future are expected to compensate for the neglect of this field of knowledge.

2. Work on a large scale (1:25,000) morphological map of Poland has now been started. This task, which has been taken up by the Geographical Institute of the Polish Academy of Sciences in Warsaw, will call for considerable efforts over quite a number of years. In this connection there has arisen the problem of the genetic definitions for slope forms and of the method of indicating them.

3. Economic planning calls for a thorough knowledge of slopes. This is particularly so as regards „soil erosion" affecting agriculture. Polish geographers are much concerned with research studies over soil erosion and have made a not inconsiderable contribution to the investigation work undertaken by soil specialists and meliorators.

Climatic morphology, quite a favourite theme with Polish geomorphologists, also involves the slope problem. Such agents of slope sculpture as rock weathering processes or the transporting of weathered material are dependent on climate. Various slope forms are an expression not of the local geological structure only but also of climatic conditions. Changes in climate may be traced through changes in slope morphology and those occurring in mantle rocks coating slope surfaces.

The land relief of the Polish landscape was carved out mostly during the Tertiary. During the Pleistocene, it suffered marked alterations, yet retained the general contours acquired at the close of the Tertiary. Two cardinal periods of slope evolution may thus be said to have existed — that of the Tertiary, particularly in the younger phases, the Miocene and the Pliocene — and the Pleistocene where the Periglacial phases predominated. Research studies on the slope problem in Poland are, therefore, mainly concerned with these two periods.

Tertiary slopes have been preserved in the Sudeten, the Carpathians and the Polish Plateaus. Those of the Sudeten have been recorded by A. Jahn *(9)* and St. Szczepankiewicz *(24)*. Kaolinised detritus material still occurs on the Sudeten surfaces. The Tertiary Carpathian slopes have been described by M. Klimaszewski *(13)*. They are overlaid by Pliocene lacustrine formations encountered in the Carpathian basins. The Tertiary evolution cycle of the slopes within the Lublin Plateau has recently been interpreted by A. Jahn *(11)*. This author believes that about the close of the Sarmatian and during the Pliocene, the denudation escarpments were formed and, under conditions of a semi-arid climate, were subjected to destruction, dislocation and retreat. In the forefield of these escarpments, extensive pediment-like surfaces developed, constituting the leading type forms of the Polish highlands which have persisted from Tertiary times.

Slopes referable to the second period of evolution, e. g. the Periglacial slopes, are of frequent occurrence in the mountains and highlands of Poland (J. Dylik, *4*). Periglacial mantle rock which coats them — rock debris for instance — and, even more, the solifluction products common on mountain and highland slopes in Poland, all testify that the majority of slopes can be correctly assigned to this second period. Periglacial slopes of the Carpathians, together with solifluction in this area, have been investigated by M. Klimaszewski *(12)*. The Periglacial landscape of Central Poland particularly that of the Łódź Highland, has been described by J. Dylik *(3)* with the cooperation of scientific workers of the Łódź Institute of Physical Geography staff. The Periglacial slopes of the Lublin Plateau have been studied by A. Jahn *(11)*. Polish geomorphologists agree that Periglacial slopes referable to the last (Baltic) glaciation period have, up to date, persisted unaltered in many areas. J. Dylik *(5)* suggests that the Periglacial slopes were formed along an evolutionary pattern characteristic of regions with semi-arid climate. Pediment-like surfaces have formed at the foot ot these slopes.

The post-glacial development of slopes and recent slope evolution processes constitute another and separate problem. R. Galon *(8)* has investigated slopes of the Vistula valley near Torun, in the area belonging to the youngest glaciation belt. He has observed a cyclic pattern in the evolution of these slopes, degraded and reduced in post-glacial times. Lateral fluvial erosion renovates and accelerates the slope denudation cycle (undercut slope).

A new concept regarding slope development has been advanced by A. Jahn *(10)* based on the light shed by what is called the "denudation balance". It is based on a scheme whereby the activities of slope processes are limited to two directions namely the perpendicular and the parallel to the slope. Weathering processes are factors in the former direction. The results of such processes may be defined as "weathering production" of the slope or what is called by W. Penck the *"Gesteins-aufbereitung"* (rock preparation). These processes are responsible for the gradually increasing thickness of loose material layers (rock debris) coating the slopes and readily susceptible to gravitation forces. To the other group may be assigned slope processes, doing work in the removal of eluvial or deluvial material (mantle rock). Such processes include slope transport referable to gravitational mass translocation of waste rock (German *"Massenbewegung"*), rain gullying (rainwash) and deflation.

The inter-ratio of these two processes — eluvial and deluvial accumulation — to denudation or bulk transport is a decisive factor in slope formation. The author calls it the "balance" of slope denudation. This may be positive when denudation transport clearly exceeds the formation of the products of weathering action and a solid rock is unmantled on the slope. Or it may be negative, with the continuous thickening of mantle rock coating the slopes, thus delaying the action of weathering. Finally there may also be an equilibrium "balance". This is indicated by the constant occurrence and uniform thickness of the debris layer on the slope.

The author stresses the somewhat rare occurrence of the equilibrium "balance". Actually, the majority of slopes suffering denudation show a surplus (positive) in the upper parts and a deficit (negative) in the lower portions. An equilibrium balance concerns the central sector of the slope, viz. the part situated around that point in the profile of H. Baulig's hypothetical slope which he calls the *"point d'inflexion"*. This equilibrium balance is typical of gravitational slopes *sensu stricto*, where the loss of detritus through gravitational transport is counterbalanced in the known manner, by products of weathering. An equilibrium balance results in uniformity of slope gradient. Steep, young slopes reveal positive balance, while negative balance of denudation is characteristic of old, gently inclined slopes.

The investigations now proceeding concerning slopes in Poland are pursued in consonance with views commonly held concerning morphologic studies. The various slope forms are recorded and classified from the point of view of processes responsible for shaping them, while the processes are evaluated not only qualititavely but also quantitavely. Hence the tendency to experiment in the laboratory and in the field with a view to evolving evidence for an adequate insight into the several processes with special reference to the intensity of their action.

Virtually all other university departments of geography in Poland, in addition to the Polish Academy's of Sciences Institute of Geography have started regional research work in this field of science throughout the country. The departments of Wrocław and Łódź have outpaced other centres in their slope investigation studies. These studies were started only a few years ago, a period of time too short, naturally, to allow any far reaching conclusions based on adequate data concerning the development of recent slope morphology.

Slope formation may take place under natural conditions undisturbed by either the direct or indirect interference of the activity of man, or under semi-natural conditions dependent on the type of human economic activity. Natural denudation processes are studied in National Parks, above all those in areas within the Karkonosze and the Tatra Mts. Periglacial conditions there prevail above the uppermost forestline. In the Karkonosze Mts., slope observation is carried on in spring and autumn seasons. During the spring, particularly in places where there occur considerable accumulations of snow, the washing away process is strongly in evidence. Mass-waste connected with solifluction is of less importance. During the autumn soil-ice (Germ. *Kammeis),* occasionally forming in layers up to 10 cm thick — as recorded in November of 1955 — causes considerable destruction.

Outside the high mountain chains, the remaining districts of Poland are uplands of moderate height, downs and lowlands, under farm and forest culture. Here slope destruction by denudation is accelerated by the action of man. The question hence arises as to the relation of morphologic changes brought about either by the direct or indirect action of man (deforestation and ploughing) to those resulting from natural geomorphic processes developing under climatic conditions now prevailing in Poland. These natural processes must be determined with a view to correctly estimating the denudation accelerated by man's activities. This is the main task facing scientists engaged in dynamic geomorphology in general, and more particularly so in slope investigation in that part of the Polish landscape now under cultivation.

Geography research centres at Łódź, Lublin and Toruń have taken up investigation work of this kind. It is closely connected with non--geographical research studies concerning agriculture and soil science to which much attention is now being paid in Poland. Soil erosion processes are under constant observation on plots of two agricultural experiment stations — Sławin near Lublin on loess soil, and Minikowo near Bydgoszcz on ground moraine. Quite a number of papers dealing with soil erosion have lately been published, namely those by St. B a c *(1)*, S. Z i e m n i c-k i *(28)*, A. R e n i g e r *(18)*, together with a handbook on this subject, the joint work of B. D o b r z a ń s k i, A. M a l i c k i and S. Z i e m n i c k i. The rate of denudation on loess-covered slopes in the Uplands of Poland has already been evaluated. The average thickness of the soil layer being worn away annually from slopes with a 10—15 gradient is estimated at about 4 mm.

Noteworthy are observations made by geographers from Łódź within the Łódź Upland area and in the Kaczawskie Mts. of the Sudeten (J. D y-l i k *13*, Ł. P i e r z c h a ł k o *17)*. It has been observed that in springtime, fields lying on slopes are strongly wasted by thaws and melt-water. Also that on some slopes a soilcreep of the solifluction type occurs. This is noticeable after severe winters when the ground freezes down to a depth of 1 m., as was the case in Poland during the winter of 1954. Slopes with a cold, north-facing surface display stronger development of denudation processes than the warm or south-facing slopes. This has been confirmed on the evidence of slope investigation studies in other parts of Poland, as for example in the Lublin Upland. It would appear that this is a general law as affecting slope denudation under the recent climatic conditions in Poland. Its action is responsible for the asymmetry observable in the cross sections of valleys and ridges and for the increase in the asymmetry already existing since Periglacial times.

To sum up the present review of the work undertaken in Poland in the way of slope problematics, the following cardinal points should be stressed as being those on which all the research studies are hinged.

1. T h e T e r t i a r y s l o p e, f e a t u r e s o f i t s p r o f i l e a n d c h a r a c t e r s o f e v o l u t i o n. Slope retreat at the close of the Tertiary, connected with the climate prevailing at that time, is here a fundamental problem. The question to be solved is whether this slope retreated in parallel without modification of its inclination — problem of Tertiary pediments — or was levelled by its upper part being degraded and its foot piled over with debris material. The opinions of Polish geomorphologists differ on this question. They believe that the process here considered was connected with the type of rock building up the slope; others draw attention to the significance of local climatic conditions prevailing during slope evolution, so different within the Sudeten basins, where they approach the continental type, from those within the marginal mountain area.

2. P e r i g l a c i a l s l o p e. Slope problems in areas of loose rocks accumulated by glaciers are considered on a separate footing from those in solid rocks of the Polish mountain and upland areas. Laws common in Periglacial slope formation, referable to prevailing climatic conditions, have apparently been at work all over Poland, independent of the type of rock. This was the gravity slope and it experienced, at least partially, parallel retreat. Hence the problem of sub-slope or slope planed surfaces, of the pediment type, and that of the altiplanation terraces.

3. The Recent slope and present slope processes. This is a problem of the evaluation of such processes in view of the climate now prevailing in Poland, as well as an estimation of the slope processes shaping the anthropogenic forms and deposits. The problem of soil erosion here becomes paramount.

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THE ACTION OF RIVERS DURING THE GLACIAL EPOCH AND THE STRATIGRAPHIC SIGNIFICANCE OF FOSSIL EROSION SURFACES IN QUATERNARY DEPOSITS *

The problem considered is as follows:

To what extent did the climatic fluctuations of the Glacial Epoch — which found their expression in Glacial and Interglacial Phases — influence the change of the geomorphologic process in glaciated areas, or areas remaining under the influence of glaciation?

The problem involves, chiefly, the examination of river action. Numerous attempts have already been made to solve this key problem of the Quaternary Period.

It has been assumed, for instance, that alluvial sedimentation took place during the Glacials and that valley gravel-sheets were cut up in the Interglacials. The Glacial and Interglacial maxima (peaks of the climatic curve) were periods in which different morphogenetic processes took place *(1, 2)*.

Another, more modern conception is that, from the morphological point of view, it is not the climate of the peak phases of the Glacials and Interglacials which is the most important, but the climatic changes between these extreme stages, i. e. sedimentation between the Interglacial and the Glacial Phases, and the erosion occurring between these Phases *(3, 5)*. Trèvisan *(6)* has called the first of these phases, the anaglacial, and the second — the kataglacial.

The author of the present paper wishes to submit, on the basis of the results of research work effected in the Lublin Plateau[1]. a new conception by way of explanation of this question.

The stratigrafication of quaternary deposits of the Lublin Plateau was determined, on the basis of numerous outcrops and boreholes. As a result of this investigation the morphological history of this area, from the Tertiary, through all the Glacial Periods, to the Holocene was examined.

It was established as a fundamental fact that each series of glacial and interglacial deposits is, as a rule, separated from the others by

* First published in Bulletin de l'Académie Polonaise des Sciences, Cl. III, vol. III, No. 10, 1955.

[1] A detailed proof of this thesis will be found in an extensive study on the *Plateau of Lublin — Morphology and Quaternary Deposits* in "Prace Geograficzne Instytutu Geografii PAN" (Geographical Studies of the Polish Academy of Sciences, Institute of Geography). Warszawa 1956.

horizons of sedimentary incompatibility, — in other words, by surfaces of erosion or denudation. Each glacial series is dissected at the top. Interglacial deposits rest on these erosion surfaces. These phenomena appear, even though they cannot be established with complete certainty, in the deposit series of more ancient Glacial Phases; they become, on the other hand, increasingly evident in the deposits of the younger Pleistocene.

Such a development may be noted in the quaternary deposits which have been buried in the Pliocene Wieprz Valley (Fig. 1).

This is shown, for example, in the section of the valley below the mouth of the Bystrzyca, a section which has been reconstituted on the basis of numerous profiles of the valley slope, and of boreholes on the valley bottom (according to K a r a s z e w s k i, 7). The fossil erosion surfaces separate „cold“ deposits (moraine-till, fluvioglacial sand) from “warm” deposits (fluvial sands, lake deposits and peat).

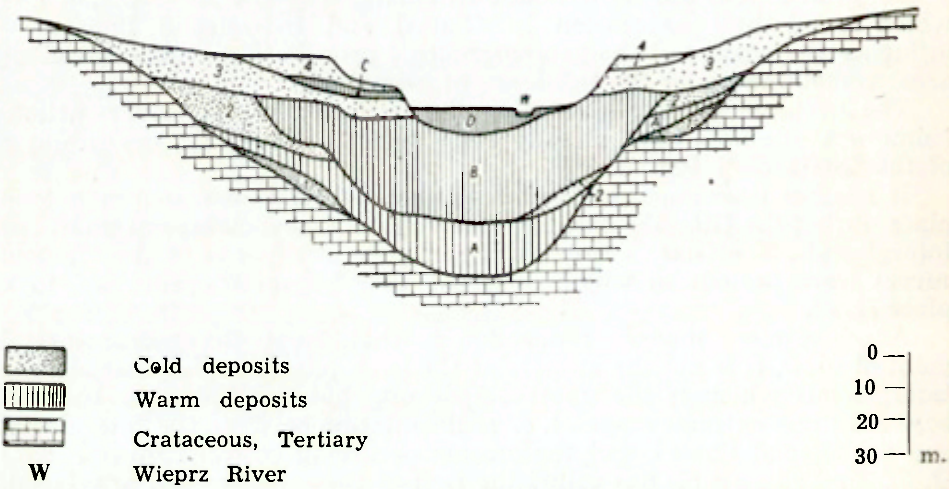

Fig. 1. Schematic section of the Wieprz valley, below the mouth of the Bystrzyca, drawn on the basis of material actually obtained from borenholes and excavations in the vicinity of the villages of Syrniki, Czerniejów, Rokitno and Spiczyn. The interposition of sedimentary cold series (moraine-tills, fluvioglacial, sands, boulders) between warm ones (fluvial sands, lake silts, peats) is clearly visible. The cold deposits (1,2,3,4) originate from the Glacial, the warm ones (A, B, C, D) — from the Interglacial and Post-Glacial Phases. Between these are deep erosion surfaces, corresponding to the different stages of development of the Wieprz valley during the Quaternary Period.

In the Wieprz valley, south of Krasnystaw, the cold deposits with a Dryas-flora (silt, clay and sand) rest on a deep erosion form, and are also dissected ot the top by a similar surface.

The position is reversed in the valleys of the Bug and of the Huczwa, where a fossil erosion valley is buried beneath a thick series of warm deposits (with a paludina fauna). The fossil valley was cut in the deposits of the older Pleistocene.

This stratigraphic regularity can be clearly traced from the deposits of the last glaciation up to contemporary times. It is a branch of the climatic curve of the glaciation — if T r e v i s a n's definition of the kataglacial phase is accepted. The principal fluviatile terrace in the valleys of the Lublin Plateau was formed in the periglacial zone of the last glaciation. It is dissected to a depth of approximately 20 to 30 metres. Into this form, warm Holocene sediments, i. e., sediments of an interglacial type, are deposited (Fig. 1).

From this data it may be concluded that sedimentation in river valleys took place both during the Glacial Phases (cold sedimentation) and the Interglacial Phases (warm sedimentation). In between those there were always erosion phases which may be called, according to Trevisan's terminology, the phases of anaglacial (before glaciation) and kataglacial (after glaciation) erosion.

It will be possible to locate these phases more accurately in the climatic curve by taking into consideration the changes in temperature and precipitations. K l u t e *(8)* once stated that these two curves were parallel one to the other, i. e., that the fall in the air temperature during the glaciation produced a proportionate fall in the volume of precipita-

Fig. 2. The erosion and accumulation cycle of fluvial action in the Pleistocene. ——— temperature. ———— precipitations. *A* — anaglacial phase. *K* — kataglacial phase. *E* — erosion.

tions. It would appear, however, that this is not the case. The curves tend to intersect. During the Interglacial Phases, the total of precipitations was less than the thermal capacity of those periods, and above this limit during Glacial Phases. It is a consequence of this fact that glacial cooling produced a marked, brisk exchange of air masses, and the edge of the icecap was a zone of cyclons.

The erosive action of flowing waters coincided during the period of change of the Glacial climatic system, with the Interglacial Phases and viee versa. The Interglacial system itself was not conducive to any major degradation, against which the compact vegetation (forest) gave full protection. Neither did the glacial (periglacial) system admit, in spite of a lack of vegetation, of any deeper river cuttings, for the subsoil was frozen and the action of valley waters too weak. They were charged with material produced by the denudation — very intense at that period — of slopes. The period of passage from one system to another — shown by the intersection of the temperature and precipitation curves — produced conditions conducive to erosive action. Hence, it is from that period that the erosion surfaces, known among the quaternary deposits of the Lublin Upland, originate.

The results of these considerations are summarised in the diagram (Fig. 2), which shows the course of the temperature and of precipitations during the Glacial and Interglacial Phases. It may be seen that the erosion phases, dividing the Interglacial from the Glacial (Ea), and the Glacial from the Interglacial (Ek), indicate the limits between the cycles of warm and cold sedimentation. Each cycle is composed of two parts, which — enlarging on Trévisan's *(6)* concepts — may be called the anaglacial and kataglacial parts. The turning point of each cycle is equivalent to a climatic culmination or depression. Thus, each Interglacial Phase is made up of kataglacial (K_i) and anaglacial (A_i) parts; the same is true of the Glacials (K_g and A_g).

The passage from Interglacial to Glacial Phases was not characterised by continuous, uniform sedimentation. It consisted in warm interglacial sedimentation (A_i) and cold glacial sedimentation (A_g), separated by erosion phases (E_a). In the passage from Glacial to Interglacial Phases, the order was reversed.

To sum up the results of these considerations of a morphologic and climatic nature, it should be stressed once more that they are based on geologic data, i. e., on an accurate stratigraphy of quaternary deposits, chiefly of the River Wieprz and River Bug valleys. The action of these rivers was sedimentary and erosive and its fluctuations are clearly correlated with changes of climate. The erosion surfaces which divide the cold from the warm deposits are not of a local or sporadic nature, but, being encountered over considerable areas, have a general significance. Hence their great stratigraphic importance. An erosion surface may, on close investigation, become a stratigraphic index horizon, no less essential and important than the sedimentary levels.

This is a point of a paleomorphological nature which the author particularly wishes to stress.

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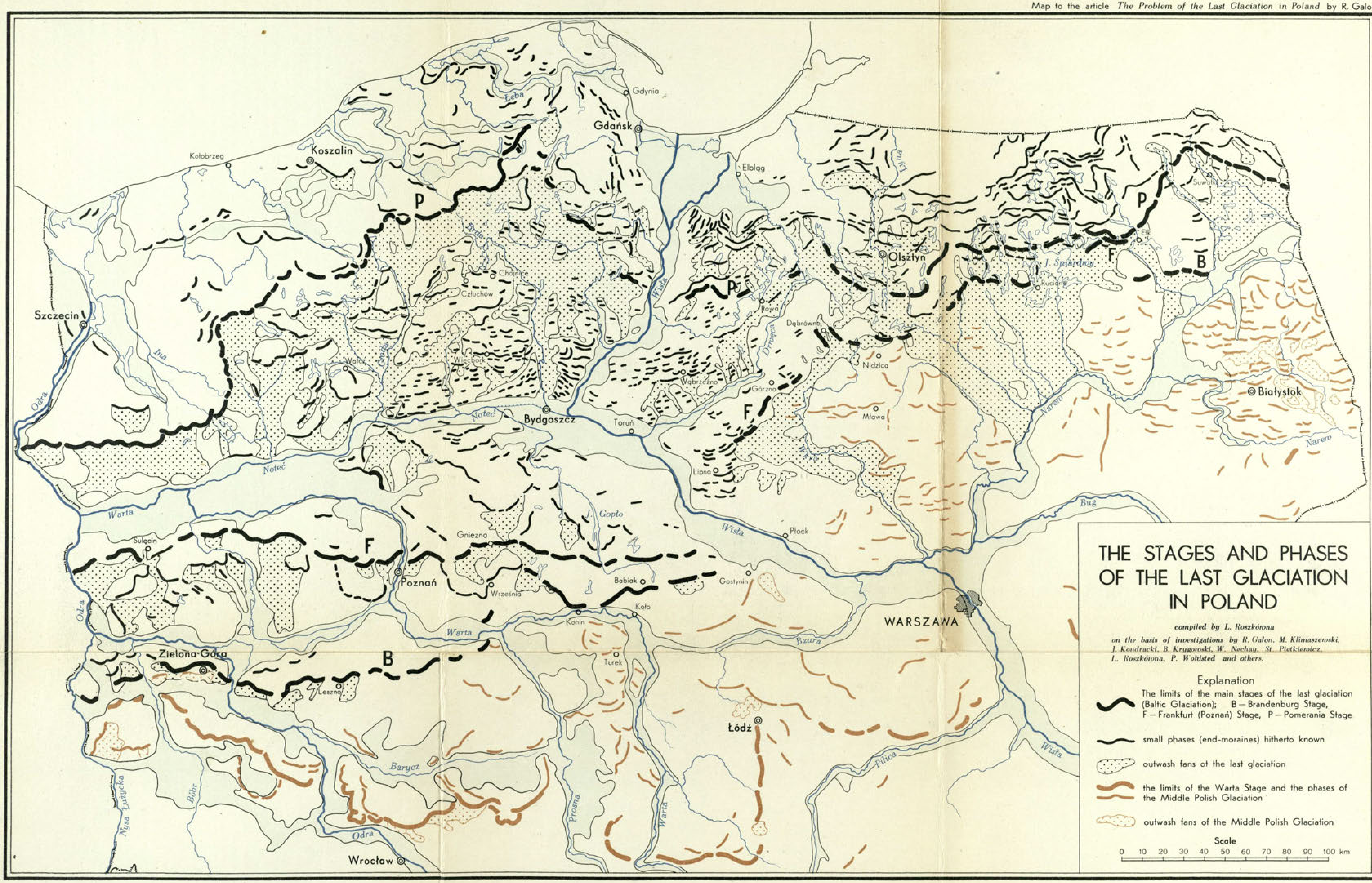
CONTENTS

Map to the article *The Problem of the Last Glaciation in Poland* by R. Galon



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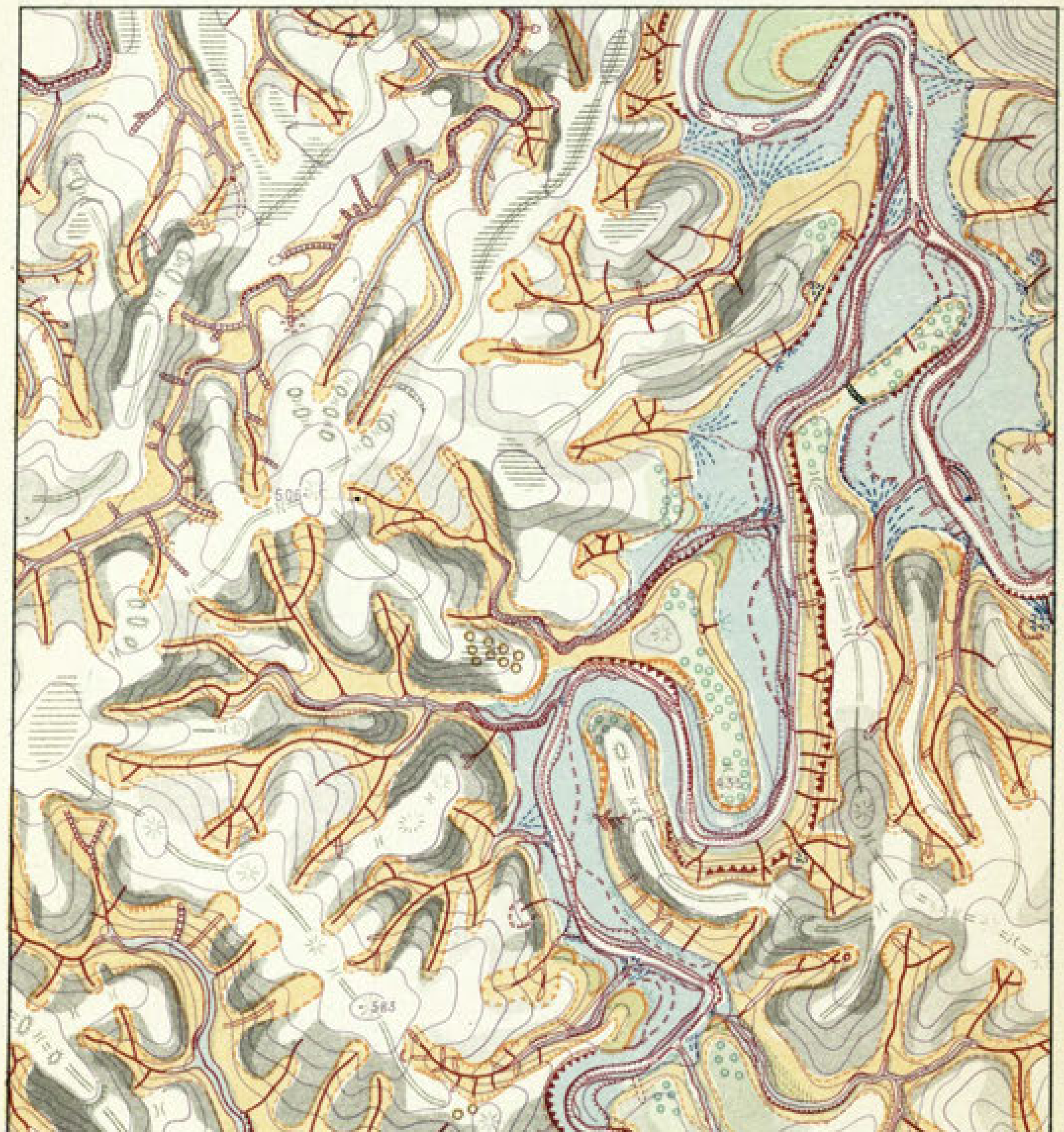
DETAILED GEOMORPHOLOGICAL MAP OF POLAND

Samples from the Area of Southern Poland

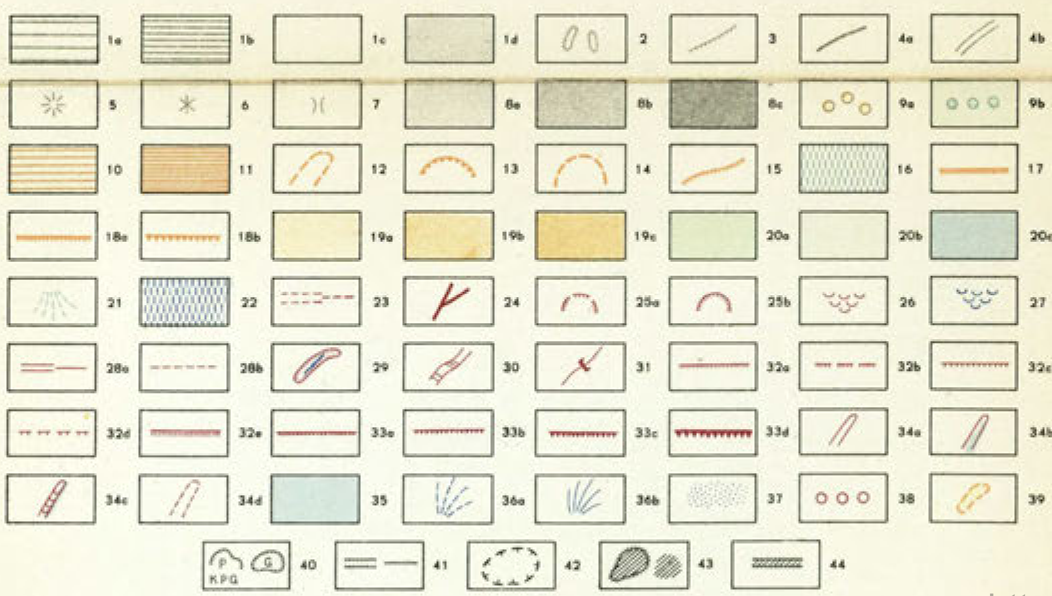


0 1 2 km

Prepared by T. Galarowski, on the basis of the geomorphological survey by T. Galarowski, T. Gerlach, S. Gilewska, K. Kaczmar, L. Starkel and M. Tyczyńska.

0 1 2 km

Prepared by K. Kaczmar, on the basis of geomorphological survey by M. Karaś, L. Starkel and M. Widło.



Tertiary Forms. 1. Fragments of surfaces of planation: a) belonging to higher level; b) belonging to lower level; c) inclined less than 5%; d) inclined 5 – 15%. 2. Denudative remains (monadnocks). 3. Edges between surfaces of planation differing in age. 4. Ridges at the intersection of valley slopes: a) narrow and sharp; b) broad and rounded. 5. Mound-like summit. 6. Conical summit. 7. Mountain pass. 8. Valley slopes mantled with waste or solifluction: a) inclined 5 – 15% or 4° – 9°, now slightly denuded; b) inclined 15 – 35% or 9° – 20°, now markedly denuded or undercut; c) inclined over 35% or over 20°, partly rocky, now intensively denuded or undercut. 9. Pliocene river terraces: a) covered by Pliocene river sediments; b) cowered by Pleistocene river sediments (Cracovien gl.).

Pleistocene Forms. 10. Erosional-denudative plain. 11. Erosional terrace plain. 12. Trough-like valley. 13. Niche or rear edge of a land slide. 14. Depression in a valley slope. 15. Structural – denudative break of slope. 16. Solifluction. 17. Edge of river terrace, 6 – 12 m relative height. 18. Slopes undercut by erosion: a) 6 – 12 m. rel. height; b) over 12 m. rel. height. 19. Valley slopes mantled with waste or solifluction: a) inclined 5 – 15% or 4° – 9°, now slightly denuded; b) inclined 15 – 35% or 9° – 20°, now markedly denuded or undercut; c) inclined over 35% or over 20°, partly rocky, now intensively denuded or undercut. 20. Accumulative river terraces: a) high terrace (Cracovien); b) medium terrace (Varsovien I); c) low terrace (Varsovien II). 21. Low alluvial cones (Varsovien II).

Holocene Forms. 22. Deluvial plain. 23. River bed less than 1 m. deep, eroded in debris. 24. V-shaped valley 25. Niche or rear edge of a land slide: a) established; b) fresch. 26. Soil creep or earth flow. 27. Tongue of a land slide. 28. River bed, less than 1 m. deep: a) eroded in rock; b) eroded in debris. 29. Cut off river bed, fresh, with water (for height of edges see edges of terraces). 30 Low steps in river bed (rapids). 31. Outlet step of a hanging valley. 32. Edges of river terraces and alluvial cones: a) up to 3 m. high, well preserved; b) up to 3 m. high, badly preserved; c) 3 – 6 m. high, well preserved; d) 3 – 6 m. high, badly preserved; e) 6 – 12 m. high, well preserved. 33. Slopes undercut by erosion: a) less than 3 m. high b) 3 – 6 m. high; c) 6 – 12 m. high; d) above 12 m. high; 34. Small valleys created by periodic streams and denudation: a) ravins; b) loess canyon; c) „tielke"; d) ablation troughs. 35. River flood plain. 36. Alluvial fan with declivity of: a) less than 6°; b) more than 6°. 37. Gravel banks in river bed 38. Suffosional pits. 39. Sand dunes, atypical. 40. Quarries, clay pits, sand pits. 41. Road cuttings. 42. Hollows caused by minings subsidence. 43. Mining slag and industrial tips. 44. Railway and road tips, embankments.

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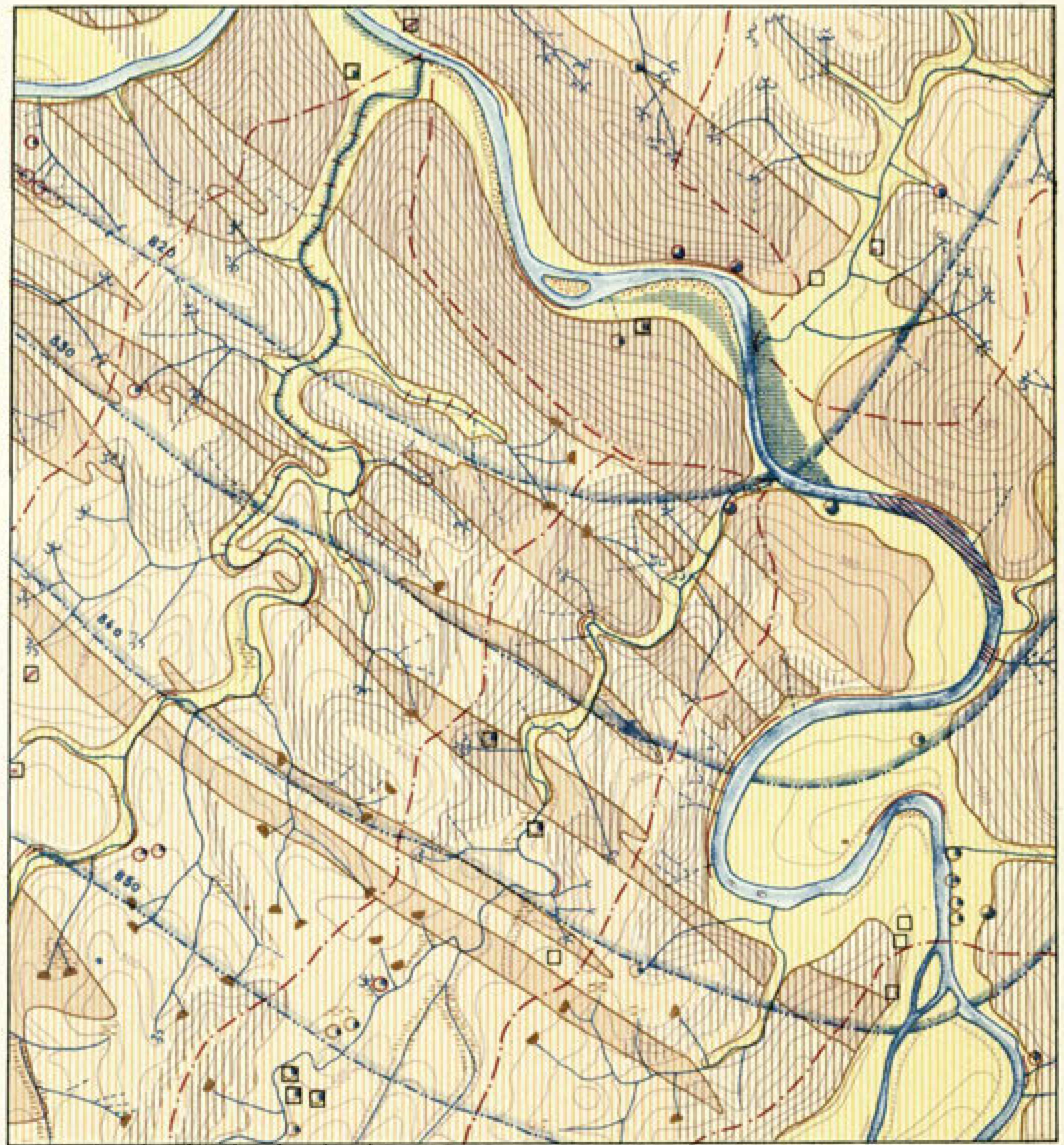
HYDROGRAPHICAL MAP OF POLAND

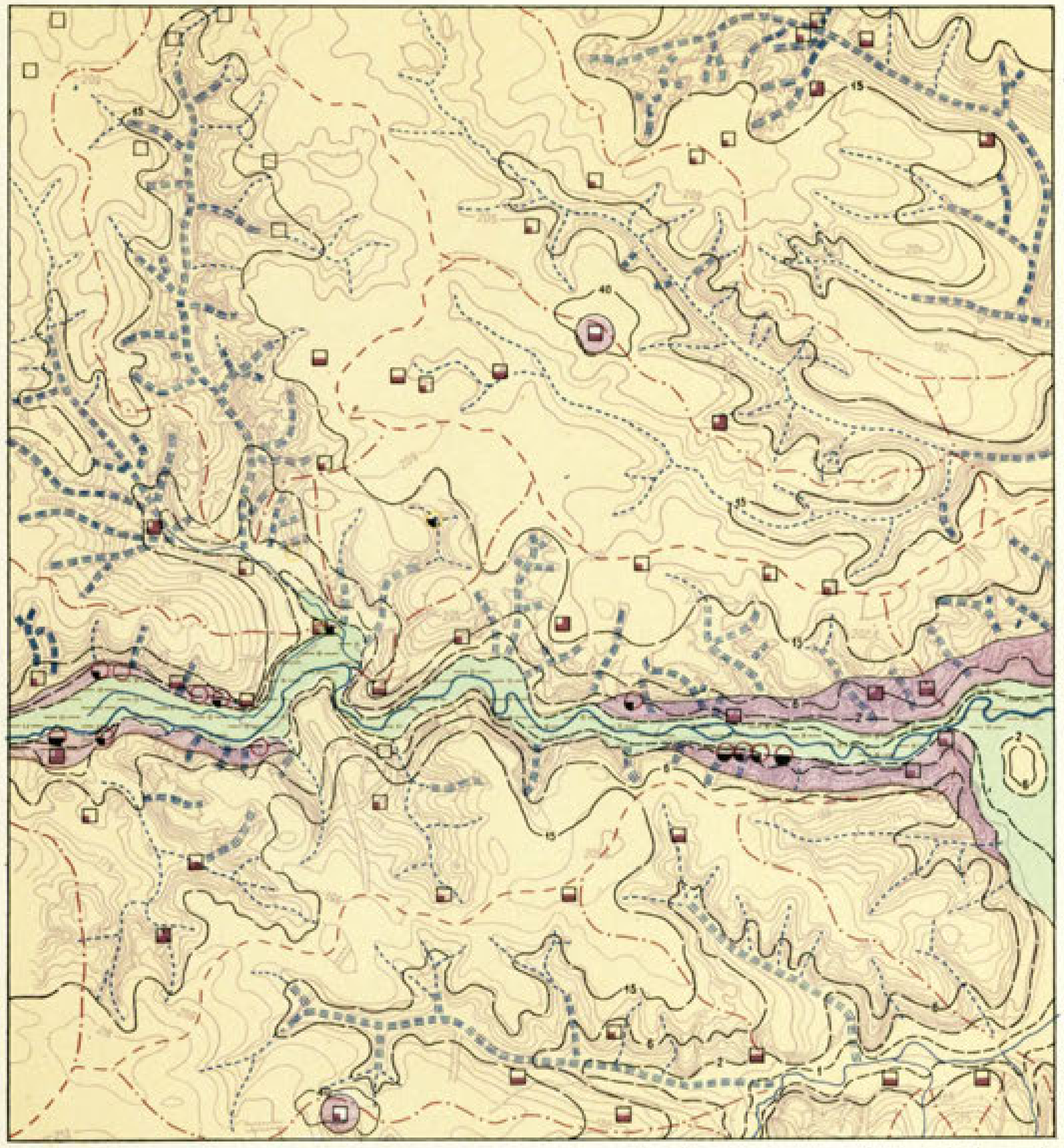
Samples from the Area of Southern Poland:

A. Mountainous Region



Prepared by J. Dynowska, on the basis of hydrographical survey by W. Feidarz, S. Kurzejowski, W. Orłowski, A. Rajwa, M. Widło, K. Wit and Z. Ziemońska; geological structure after Wdowiarz

B. Upland Region



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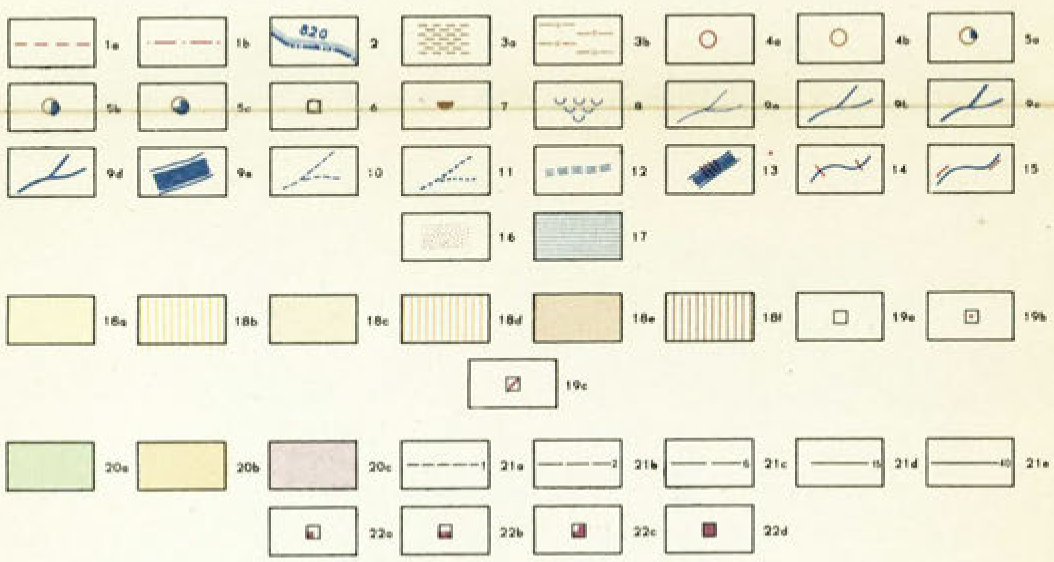

Both Maps: 1. a) Watershed of second (II) order; b) Watershed of third (III) order. 2. Isohyets. 3. a) Ground permanently waterlogged; b) Ground periodically waterlogged. 4. a) Springs in rocks; b) Springs in waste. 5. Outflow of springs: a) 0.1 – 0.5 l/sec; b) 0.5 – 1.0 l/sec; c) 1.0 – 10.0 l/sec. 6. Built-up spring. 7. Boggy spring. 8. Seepage out of waste. 9. Permanent streams with quantity of flow: a) up to 0.1 m^3/sec; b) 0.1 – 1.0 m^3/sec; c) 1.0 – 5.0 m^3/sec; d) 5.0 – 10.0 m^3/sec; e) 10.0 – 50.0 m^3/sec. 10. Periodic streams. 11. Ephemeral streams possesing beds. 12. Ephemeral springs flowing over the whole breadth of valley bottom. 13. Steps and rapids in river bed. 14. Waterfall. 15. Undercut river bank. 16. Gravel and sand banks in river bed. 17. Area annually flooded.

Map A: 18. Aquiferous strata: a) highly aquiferous bedrock; b) highly aquiferous waste mantle; c) moderatly aquiferous bedrock; d) moderatly aquiferous waste mantle; e) poorly aquiferous bedrock; f) poorly aquiferous waste mantle. 19. Depth of water table in wells: a) below 1 m; b) 1 – 2 m; c) 2 – 6 m.

Map B: 20. Kinds of utilized ground water: a) water in valley alluvium; b) water in Quaternary deposits (loess, sand under loess, sand under boulder clay); c) water in Sarmatian sandstones and sands. 21. Hydroisobaths of the utilized ground water table (thickness of the „dry layer"): a) 1 m; b) 2 m; c) 6 m; d) 12 m; e) 40 m. 22. Depth of water in wells: a) below 1 m; b) 1 – 2 m; c) 2 – 4 m; d) over 4 m.

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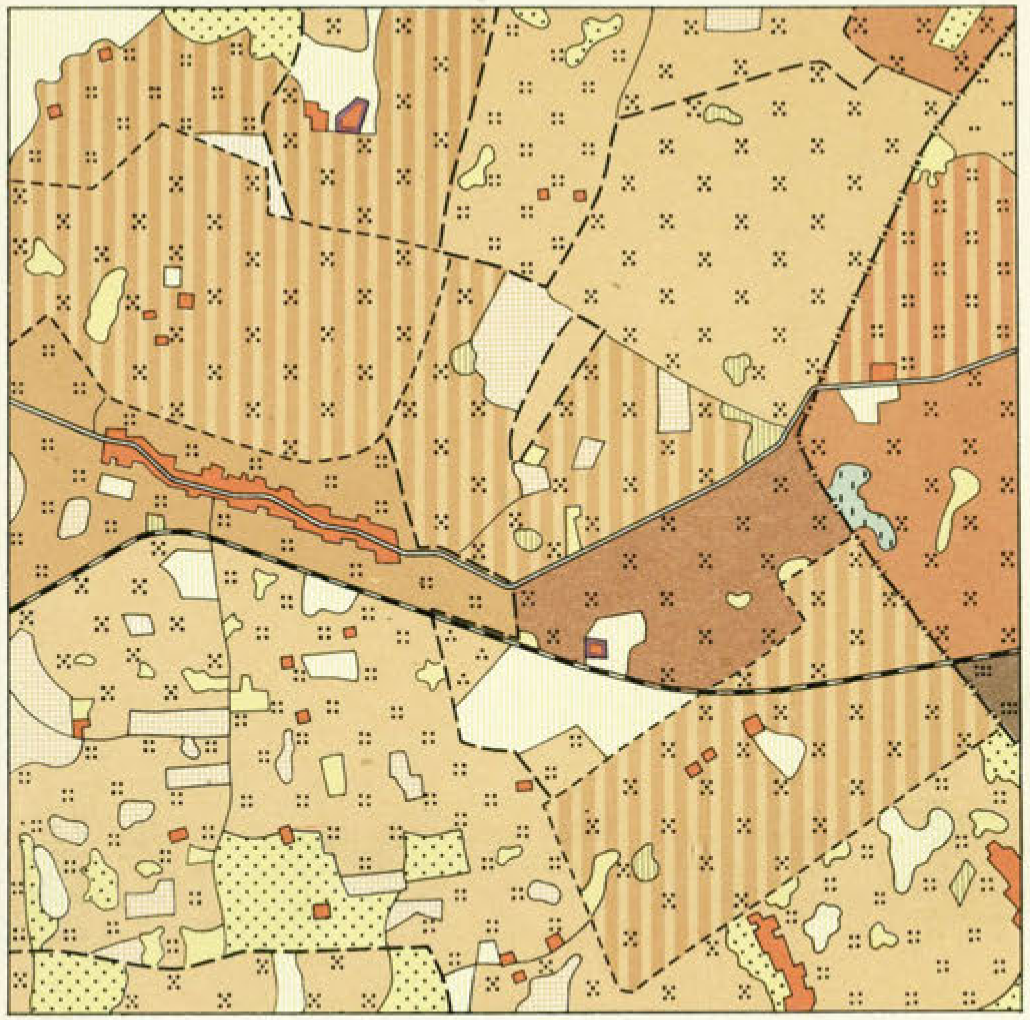
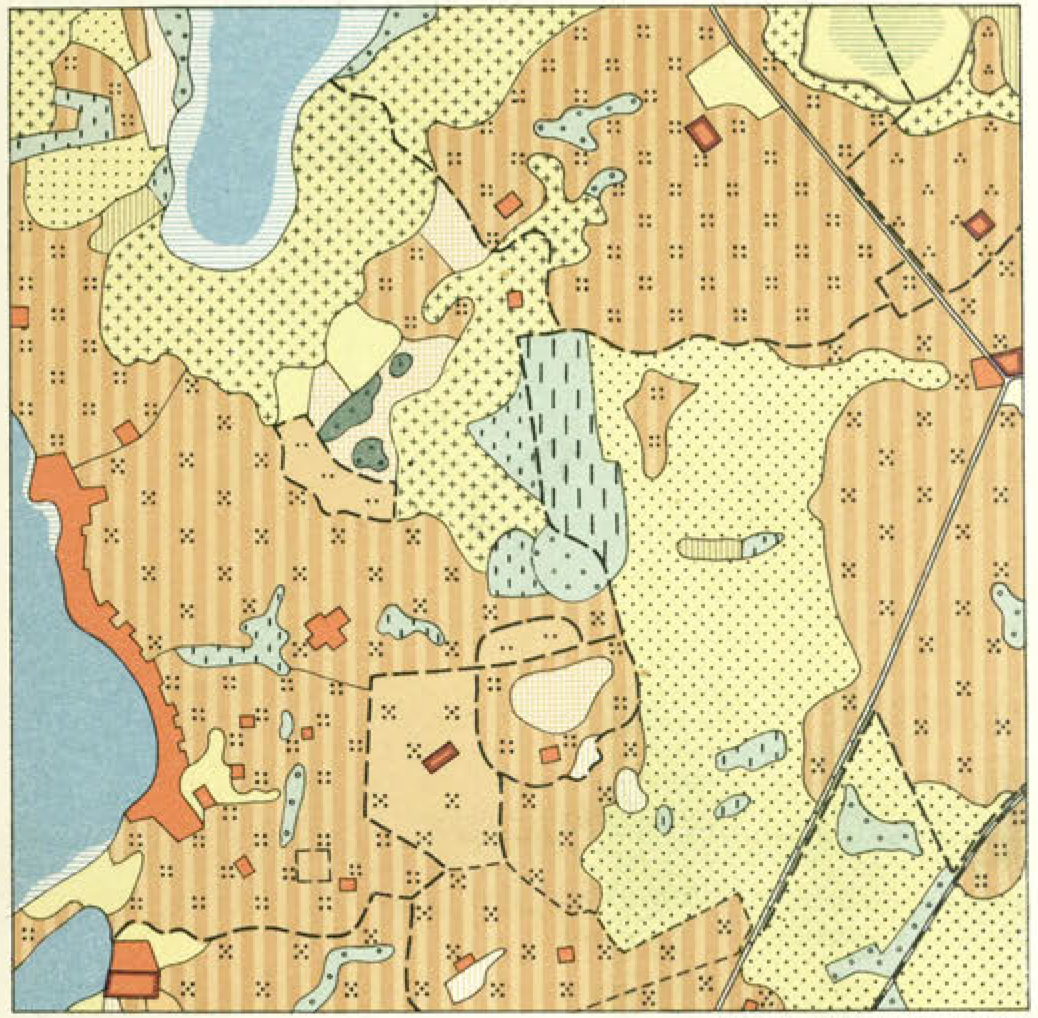
DETAILED LAND USE MAP (SAMPLES)





(prepared by R. Szczesny and H. Piskorz)

BOUNDARIES

- Boundaries of a "powiat" (country, Kreis, rajon, department)
- Boundaries of a "gromada" (parish, commune, Gemeinde)
- Boundaries of a State Farm
- Boundaries of a Cooperative Farm
- Boundaries of a block of land

COMMUNICATION

- Railroads of different gauges
- Roads
- Waters

ARABLE LAND

- Corn crops dominating
- Root crops dominating
- Fodder crops dominating
- Industrial plants dominating in crops
- Vegetables dominating in crops
- Irregular rotation
- Open field system
- 3-year rotation
- 4-year rotation
- 5-year rotation
- 6 – 7-year rotation
- Long year rotation with grass dominating

PERMANENT GRASSLAND

Meadows

- Dry grassland
- Lowland Meadows
- Marsh and fen
- Clearings
- Improved (drained) land, water meadows
- Reeds and other water plants

Pastures and rough grazing

- Dry grassland
- Lowland Meadows
- Marsh and fen
- Drainage out of use or destroyed

ORCHARDS AND GARDENS

- Market orchards and gardens
- House orchards and gardens

UNPRODUCTIVE (WASTE) LAND

- Water-logged land
- Unproductive grassland
- Rocks
- Sand and gravel
- Abandoned arable land
- Fallows

BUILT-UP AREAS AND OTHERS

- Rural settlement
- Suburban settlement
- Urban settlement
- Central urban areas
- Industry
- Technical agricultural service stations

Extraction of minerals

- Peat
- Gravel-pits
- Quarries
- Clay-pits

FORESTS AND WOODLAND

Coniferous forest and woodland:

- Dry coniferous forest
- Fresh coniferous forest
- Marsh coniferous forest

Mixed forests:

- Coniferous forest mixed with deciduous trees
- Deciduous forest mixed with coniferous trees

Dry deciduous forests (Hardwood forests):

- Oakwood
- Typical hardwood forest (Oak and ash)

Lowland deciduous forests:

- Alder woodland

- Ms. M.św. Mj. Monocultures
- Felled areas
- Young plantations
- Older plantations
- Maturing forest
- Old forest

Forest invading:

- idle pastures,
- meadows
- arable land

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A n n e x to the article *The Principles of the Geomorphological Survey of Poland* by M. Klimaszewski

TABLE OF COLOURS USED IN THE GEOMORPHOLOGICAL MAP OF POLAND

TABLE OF GEOMORPHOLOGICAL FORMS AND SIGNS USED IN THE GEOMORPHOLOGICAL MAP OF POLAND

TABLE OF COLOURS USED IN THE GEOMORPHOLOGICAL MAP OF POLAND (1 : 50 000)

Colour	Age		Factor	Action	Forms
dark blue	Neogene	flowing water and gravitation	internal	constructive	A. tectonic
pinkish mauve	Paleogene		gravitation	destructive	B. denudative
„ „	Paleogene		stream water	destructive	C. fluvial
grey	Neogene		gravitation	destructive	B. denudative
grey	Neogene		stream water	destructive	C. fluvial
grey	Neogene		surface and underground water	destructive (solution)	E. karst
orange	Pleistocene		gravitation	destructive	B. denudative
orange	Pleistocene		stream water	destructive	C. fluvial
orange+mauve	Pleistocene		fluvio-glacial water	destructive	D. fluvio-glacial
orange	Pleistocene		surface and underground water	destructive (solution)	E. karst
green	Pleistocene		gravitation	constructive	B. denudative
green	Pleistocene		stream water	constructive	C. fluvial
green+brown	Pleistocene		fluvio-glacial water	constructive	D. fluvio-glacial
red (crimson)	Holocene		gravitation	destructive	B. denudative
red (crimson)	Holocene		stream water	destructive	C. fluvial
red (crimson)	Holocene		surface and underground water	destructive (solution)	E. karst
red (crimson)	Holocene		underground water	destructive (washing out)	F. suffosion
blue	Holocene		gravitation	constructive	B. denudative
blue	Holocene		stream water	constructive	C. fluvial
mauve-lilac	Pleistocene	snow and ice	glacier	destructive	G. glacial
mauve-lilac	Pleistocene		snow	destructive	H. nival
mauve-lilac	Holocene		snow	destructive	H. nival
brown	Pleistocene		glacier	constructive	G. glacial
brown	Holocene		snow	constructive	H. nival
vermil.+mauve	Holocene		sun and ice	destructive	I. buried ice
pink	Holocene	wind	wind	destructive	J. aeolian
pale yellow	Pleistocene		wind	constructive	J. aeolian
dark yellow	Holocene		wind	constructive	J. aeolian
vermilion	Holocene	waves	lake water	destructive	K. limnic
vermilion	Holocene		sea water	destructive	L. thalasogenic
light blue	Holocene		lake water	constructive	K. limnic
light blue	Holocene		sea water	constructive	L. thalasogenic
brownish-grey	Holocene	organism	vegetation	constructive	M. organogenic
black	Holocene		man	destructive	N. anthropogenic
black	Holocene		man	constructive	N. anthropogenic

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	Sign	Paleogene	Neogene: Miocene	Neogene: Pliocene	Pleistocene: Cracovien (Mindel)	Pleistocene: Varsov. I (Riss)	Pleistocene: Varsov. II (Würm)	Holocene
A. FORMS OF TECTONIC ORIGIN								
1. Slopes of fault-line scarps, horsts and graben			navy blue					
B. FORMS OF DENUDATIVE ORIGIN								
I. Forms created by the destructive action of denuding factors								
1. Fragments of surfaces of planation including:								
a) levels of less than 5% slope		pinkish mauve	grey			orange		
b) gentle slopes with a declivity of 5—15%		pinkish mauve	grey			orange		
c) denudative outliers		pinkish mauve	grey			orange		
d) monadnocks		pinkish mauve	grey			orange		
2. Edges between surfaces of planation of different ages		pinkish mauve	grey			orange		
3. Form of ridge or spur at the intersection of the valley-slopes, created during:								
a) narrow and sharp		pinkish mauve	grey			orange		
b) broad and rounded		pinkish mauve	grey			orange		

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4. Form of summit:								
a) dome-like		pinkish mauve	grey			orange		
b) mound		pinkish mauve	grey			orange		
c) conical		pinkish mauve	grey			orange		
d) sharp (Karling, Matterhorn peak)	Y Y	pinkish mauve	grey			orange		
5. Slopes of denudative cuestas:	Surfaces covered with shades of the basic colour from light to dark							
a) very gentle with a declivity of 3—5%		pinkish mauve	grey			orange		
b) gentle with a declivity of 5—15%		pinkish mauve	grey			orange		
c) steep with a declivity of 15—35%		pinkish mauve	grey			orange		
d) very steep with a declivity of 35—100%		pinkish mauve	grey			orange		
e) precipitous, rocky, with declivity of 100—200%		pinkish mauve	grey			orange		
f) rocky faces with declivity of > 200%		pinkish mauve	grey			orange		
6. Slopes of outliers (a—f)		pinkish mauve	grey			orange		
7. Structural-denudative break of slope		pinkish mauve	grey			orange		

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8. Denudative level		pinkish mauve	grey			orange		
9. Break of slope over an undercut valley slope						orange		
10. Gully:								
a) in rock						orange		
b) in waste (weathered matter, debris)						orange		
11. Niche (recess) or rocky face left by a rock fall:								
a) old						orange		crimson
b) fresh								crimson
12. Amphitheatre scar or rear step of a rock slide:								
a) old						orange		crimson
b) fresh								crimson
13. Amphitheatre scar or rear step of a land slide:								
a) old						orange		crimson
b) fresh								crimson
14. Niche or edge of a rock slump:								
a) old						orange		crimson
b) fresh								crimson
15. Niche or edge of a land slump:								
a) old						orange		crimson
b) fresh								crimson
16. Small landslides and slumps								crimson
17. Surface of soil creep or earth flow								crimson
18. Valley created by corrasion								
19. Depression in a valley slope								
20. Small denudative relicts (monadnocks):						orange		
a) rocky ribs								
b) rocky walls						orange		crimson
c) rocky buttresses						orange		crimson
d) rocky pulpits						orange		crimson
e) mushroom-rocks						orange		crimson
f) rocky needles						orange		crimson
g) erratic blocks						orange		crimson
h) felsenmeer						orange		crimson
						green		blue

	Sign	Paleogene	Neogene: Miocene	Neogene: Pliocene	Pleistocene: Cracovien (Mindel)	Pleistocene: Varsov. I (Riss)	Pleistocene: Varsov. II Würm	Holocene
II. Forms created by the constructive action of denudative factors:								
1. Rock fall talus, piles of coarse rock debris						green		blue
2. Scree						green		blue
3. Talus cones						green		blue
4. Cones of talus-and-landslide origin						green		blue
5. Landslide tongues						green		blue
6. Talus-alluvial cones						green		blue
7. Talus streams						green		
8. Plains of solifluction accumulation						green		
9. Plains of deluvial accumulation								blue
C. FORMS OF FLUVIAL ORIGIN								
I. Forms created by the destructive action of flowing water (rivers) with the cooperation of denudation:								
1. Valley slopes cut out during:								
a) very gentle declivity of 3—5% (2—4°) mantled with waste or solifluction, now slightly denuded	Surfaces covered with shades of the basic colour from light to dark	pinkish mauve	grey			orange		crimson
b) gentle declivity of 5—15% (4—9°) mantled with waste or solifluction, now slightly denuded		pinkish mauve	grey			orange		crimson
c) steep declivity of 15—35% (9—10°) mantled with a weathered layer undergoing degradation or solifluction, now markedly denuded		pinkish mauve	grey			orange		crimson
d) very steep, partly rocky, with declivity of 35—100% (19—45°), now intensively denuded		pinkish mauve	grey			orange		crimson
e) precipitous, rocky, with declivity of 100—200% (45—64°), now intensively denuded		pinkish mauve	grey			orange		crimson
f) rocky faces with declivity of 200%, now intensively destroyed (rock falls)		pinkish mauve	grey			orange		crimson
2. Erosional plain			grey			orange		crimson
3. Edge of river terrace with relative height:								
a) 3 m well preserved badly preserved						orange		crimson
b) 3—6 m well preserved badly preserved						orange		crimson
c) 6—12 m well preserved badly preserved						orange		crimson
d) 12 m well preserved badly preserved						orange		crimson

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4. Edges of alluvial cones with relative height:								
a) < 3 m well preserved badly preserved						o r a n g e		crimson
b) 3—6 m well preserved badly preserved						o r a n g e		crimson
c) 6—12 m well preserved badly preserved						o r a n g e		crimson
d) > 12 m well preserved badly preserved						o r a n g e		crimson
5. Slopes, undercut by erosion with relative height:								
a) < 3 m						o r a n g e		crimson
b) 3—6 m						o r a n g e		crimson
c) 6—12 m						o r a n g e		crimson
d) > 12 m						o r a n g e		crimsen
6. River bed:								
a) eroded in rock, deep: < 1 m, > 1 m								crimson
b) eroded in debris (alluvium), deep: < 1 m, > 1 m								crimson
7. Cut-off river beds (meanders):								
a) fresh, with water, deep (oxbow lakes)								crimson
b) old, dry, shallow								crimson
8. Steps in river bed:								
a) low (rapids or cataracts)								crimson
b) high (waterfalls)								crimson
9. Steps at the outlet of hanging valleys						o r a n g e		crimson
10. Steps of regressional terraces						o r a n g e		crimson
11. River trenches						o r a n g e		crimson
12. Small valleys created with the co-operation of denudation processes, mainly solifluction:								
a) trough-like valleys						o r a n g e		
13. Small valleys, created by periodic rivers with cooperation of denudation processes:								
a) gorges (fresh loess-canyons)								crimson
b) ravines								crimson
c) old loess-canyons								crimson
d) "tielke"								crimson
e) troughs of ablation								crimson
f) valley troughs left by landslides								crimson
II. Forms created by the accumulative action of flowing waters (rivers):								
1. River accumulation plain						Shades of g r e e n from dark to light		b l u e
2. Accumulation terrace plains with cover of river sediments of age						Shades of g r e e n from dark to light		b l u e

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3. Terrace plain with a rocky socle and a cover of river sediments of age	ooo				Shades of the green colour from dark to light			blue
4. Alluvial fan plain with a cover of river sediments, of age:								
a) declivity of surface $< 6^0$					Shades of the green colour from dark to light			blue
b) declivity of surface $> 6^0$					Shades of the green colour from dark to light			blue
5. Delta plain								blue
6. Gravel banks in river-bed								blue
7. Sandbanks in river-bed								blue
D. FORMS OF FLUVIOGLACIAL ORIGIN								
I. Forms created by the destructive action of glacial waters:							Surfaces cover'd with shades of orange from light to dark	
1. Slopes of valleys cut out by glacial waters:								
a) very gentle with declivity of 3—5%					orange + mauve			
b) gentle with declivity of 5—15%					orange + mauve			
c) steep with declivity of 15—35%					orange + mauve			
d) very steep with declivity of $>$ 35%					orange + mauve			
2. Erosional edges of glacial outwash plain (sandr) and sandr-terraces:								
a) well preserved							orange + mauve	
b) badly preserved							orange + mauve	
3. Erosional plains of glacial outwash terraces (sandr-terraces)							orange + mauve	
4. Old, dry drainage channels							orange	
5. Outliers of ground moraine on a glacial outwash plain, with their morphological borders:								
a) well defined							orange	
b) poorly defined							orange	
6. Edges of fluvioglacial cones:								
a) well preserved							orange + mauve lilac	
b) badly preserved							orange + mauve lilac	
II. Forms created by the constructive action of glacial waters:								
1. Glacial outwash plains (sandr)						green + brown		
2. Plains of glacial lake deposits						green + brown		
3. Eskers						green + brown		
4. Kames						green + brown		
5. Fluvioglacial cone plains with a cover of accumulation of age:					Shades of	green + brown		

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III. Forms created by the destructive action of subglacial water:								
1. Tunnel valley slopes								
a) gentle, with declivity of 5—15%							orange + mauve	
b) steep with declivity of 15—35%							orange + mauve	
c) very steep with declivity of > 35%							orange + mauve	
2. Potholes and plunge pools							orange + mauve	
3. Tunnel valley bottom							orange + mauve	
IV. Forms created by the constructive action of subglacial water:								
1. Eskers of subacuatic type							green + brown	
2. Eskers of tunnel type							green + brown	
E. FORMS OF KARST ORIGIN								
I. Forms created by the dissolving action of water:								
1. Forms created in "karsting" material:								
a) solution sink holes		pinkish mauve	grey			orange		crimson
b) solution sink holes and pits created by collapse		pinkish mauve	grey			orange		crimson
c) uvala		pinkish mauve	grey			orange		crimson
d) "blind valleys" created by collapse		pinkish mauve	grey			orange		crimson
e) karst depressions		pinkish mauve	grey			orange		crimson
f) collections of sink holes and pits						orange		crimson
g) hums			grey			orange		crimson
h) natural bridges						orange		crimson
i) karrenfeld						orange		crimson
2. Karst forms reproduced in insoluble strata (overlying):						orange + green		crimson + blue
a) solution sink holes						orange + green		vermilion + blue
b) collapse pits						orange		vermilion + blue
c) blind collapse valleys						orange		vermilion + blue
d) karst depressions								
F. FORMS OF SUFFOSIONAL ORIGIN (SUBCUTANEOUS EROSION)								
I. Forms created by corrasion of underground water:								
1. Suffosional (subcutaneous) dimpling								crimson
2. Suffosional pits								crimson
3. Suffosional blind valleys								crimson
G. FORMS OF GLACIAL ORIGIN								
I. Forms created by the destructive action of ice sheet								
1. End depressions (Zungebecken)							mauve	
II. Forms created by the constructive action of ice sheet:								
1. Ground moraine flat plain						Surfaces covered with shades of bronz from light to dark	Surfaces covered with shades of brown from light to dark	
2. Ground moraine undulating plain								
3. Marginal zone morainic hills								
4. End moraine hills and ridges								

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5. Depressions among morainic hills and ridges						bronz brown		
6. Drumlins						bronz brown		
III. Forms created by the destructive action of mountain glaciers:								
1. Scoured and smoothed surfaces					mauve			
2. Roches moutonees					mauve			
3. Glacial basins, round and alongated					mauve			
4. Lip of a cirque or an overdeepened glacial basin					mauve			
IV. Forms created by the transforming action of mountain glaciers:								
1. Sidewalls of glacial cirques and troughs								
a) gentle with declivity of 5—15%						Surfaces covered with shades of lilac colour from light to dark		
b) steep with declivity of 15—35%								
c) very steep with declivity of 35—100%								
d) precipitous with declivity of 100—200%								
e) rocky faces with declivity of > 200%								
2. Steps in the bottom of glacier trough							mauve	
3. Hanging valley steps							mauve	
V. Forms created by the constructive action of mountain glaciers:								
1. Plains of ground moraine							brown	
2. Uneven surface of ground (ablation) moraine							brown	
3. Ridges of accumulative terminal moraines							brown	
4. Ridges of poured moraines							brown	
5. Ridges of lateral moraines							brown	
6. Ledges of lateral moraines							brown	
7. Ridges of medial moraines							brown	
H. FORMS OF NIVATION ORIGIN								
I. Forms created by the destructive action of snow:								
1. Nivation cirques and troughs							mauve	mauve
2. Channel of avalanches							mauve	mauve
II. Forms created by the constructive action of snow:								
1. Ridges of talus brought by avalanches								brown
I. FORMS OF BURIED ICE ORIGIN								
I. Forms created by melting blocks and lenses of buried ice and ground ice:								
1. Funnel-shaped hollows and pits (Solle)							mauve + orange	vermilion + mauve
2. Depressions							mauve + orange	vermilion + mauve
3. Collections of pits							mauve + orange	vermilion + mauve

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J. FORMS OF AEOLIAN ORIGIN								
I. Forms created by the destructive action of wind:								
1. Deflation hollows								
a) fixed								pink
b) in process of dispersion								pink
II. Forms created by the constructive action of wind:								
1. Parabolic sand dunes							dark yellow	pale yellow
2. Irregular sand dunes								pale yellow
3. Fields of small dunes								pale yellow
4. Loess plains							dark yellow	
K. FORMS OF LIMNIC ORIGIN								
I. Forms created by the destructive action of lake water:								
1. Cliffs								vermilion
2. Shore platforms								vermilion
3. Raised beach plains								vermilion
4. Raised beach steps (old cliffs)								vermilion
II. Forms created by the constructive action of lake water:								
1. Beach								light blue
2. Spits								light blue
L. FORMS OF MARINE ORIGIN								
I. Forms created by the destructive action of sea water:								
1. Cliffs								
a) old (dead)								vermilion
b) undercut								vermilion
2. Shore platform								vermilion
3. Raised beach plains								vermilion
4. Raised beach steps (old cliffs)								vermilion
II. Forms created by the constructive action of sea water:								
1. Beach								light blue
2. Coastal ridge								light blue
3. Sand banks								light blue
4. Offshore bars and spits								light blue
M. ORGANOGENIC FORMS								
I. Forms created by the constructive action of vegetation:								
1. Peat marshes								

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a) convex surface of Sphagnum-bog (high bog)								brownish-grey
b) peat-bog plains (lake shore or post-lake)								brownish-grey
N. ANTHROPOGENIC FORMS								
I. Forms created by the destructive action of man:								
1. Quarries, clay pits, sand pits, gravel pits								black
2. Old mining pits								black
3. Holvegs and road cuttings								black
4. Canal cuttings								black
5. Hollows caused by mining subsidence								black
II. Forms created by the constructive action of man:								
1. Mining, slag and industrial tips								black
2. Tumuli, barrows, prehistoric earth-works								black
3. Railway and road tips								black
4. Embankments and groynes for flood prevention								black
5. Agricultural terracing								black