BERLINER GEOGRAPHISCHE ABHANDLUNGEN

Herausgegeben von Gerhard Stäblein und Wilhelm Wöhlke

Schriftleitung: Dieter Jäkel

Heft 39

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Dietrich Barsch & Herbert Liedtke

Geomorphological Mapping in the Federal Republic of Germany

Contributions to the GMK-priorityprogram IV

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Dietrich Barsch & Herbert Liedtke (Eds)

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Editorial

The priority program "Geomorphological Mapping in the Federal Republic of Germany" financed by the Deutsche Forschungsgemeinschaft (Bonn) was started in 1976 (BARSCH & LIEDTKE 1980). Now, ten years later, it will be closed, as soon as the last examples of the 26 geomorphological maps 1 : 25 000 (GMK 25) and the last ones of the 8 examples in the scale 1 : 100 000 are published. The enclosed index (BARSCH, this volume, Fig. 1) provides the situation of these examples of geomorphological maps in the Federal Republic of Germany. In addition a number of reports have been published or are in preparation which shall inform the "Scientific Community" of the results of this program.

The "GMK priority program" was founded to achieve some progress in geomorphological mapping of the relief of Central Europe. It was the aim to develop a legend and a method for the display of the most important data and information for the understanding of the geomorphic situation of an area for geomorphologists and for students interested in this field. The GMK 25 and the GMK 100 are, thus, a necessary addition to other geoscientific maps like the geological or pedological ones.

It is hoped that the impetus developed will carry on geomorphological mapping of this type (cf. maps of the GMK Type from other regions - MÄUSBACHER 1981 or GMK-Beiträge VI). It is also hoped that new regional geomorphological research in the Federal Republic of Germany has been stimulated and that the use of geomorphic data and information will be increased in other geosciences and in planning. Also new developments have been created. One of these new lines is the definition of a digitised geomorphological base map in the sense of an areal related geomorphological information system. This work will be carried out in a new priority program of the Deutsche Forschungsgemeinschaft on digitised geoscientific maps. The contribution to this program was only possible, because a part of the necessary normation was done in the GMK priority program.

During the time of the preparation of the GMK priority program as well as during the last 10 years we found a lot of support by the international scientific community. As a small thank this report shall inform our colleagues about some aspects and some results of the GMK priority project in English.

The GMK 25 will be explained as well in its international context as by a special example from the nothern Alps. The experience made during the mapping of the GMK 100 will be discussed in relation to the first sheet of this series. Regarding the use of the GMK two different examples will be displayed: one is related to the possible advantage of the GMK 25 for other geomorphologists; the other one demonstrates an application for modern environment protection. As a contribution to international communication the legend of the GMK 25 will be given in an annex in German, English, French, Spanish and Russian.

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Incorporation of the GMK 25 BRD in the international development of geomorphological maps

HARTMUT LESER

A b s t r a c t: The "Meßtischblatt Stadtremda" (plane survey sheet Stadtremda) by S. PASSARGE is the beginning of the modern geomorphological cartography. Since the numerous methods of mapping have been developed refined geomorphological maps on a large scale have been worked out concerning contents and form but the basic principles have not been changed. Geomorphogenitcally orientated maps were to the fore, but they led away from the outlines of S. PASSARGE. Thus the application of geomorphological maps sank into oblivition. Only the method of H. KUGLER and the ITC-System set up the new modern geomorphological map.

The main features of the modern geomorphological maps, which are aspired to, are: large scale, quantity, easy applicability. This requires a brick system for the legend and various information layers for the map. The GMK 25 BRD (= Geomorphological Map 1:25 000 of the Federal Republic of Germany) follows these principles.

Stellung der GMK 25 der Bundesrepublik Deutschland innerhalb der internationalen Entwicklung geomorphologischer Karten

K u r z f a s s u n g: Die moderne geomorphologische Kartographie beginnt mit dem „Meßtischblatt Stadtremda" von S. PASSARGE. Seitdem wurden zahlreiche Kartierungsmethoden entwickelt. Sie verfeinerten Inhalt und Form geomorphologischer Karten großen Maßstabs, aber sie änderten nichts am Grundprinzip. Die geomorphogenetisch gewichteten Kartierungssysteme standen dabei im Vordergrund. Sie führten aber von den Prinzipien S. PASSARGEs weg. Damit geriet auch die Anwendung geomorphologischer Karten aus dem Blickwinkel. Erst später wurde durch die Methode von H. KUGLER und das ITC-System die moderne geomorphologische Karte neu begründet.

Die Hauptmerkmale moderner geomorphologischer Karten sollen sein: großmaßstäbig, quantitativ, anwendungsfreundlich. Das setzt für die Legende ein Baukastensystem und für die Karte verschiedene Informationsschichten voraus. Die GMK 25 BRD (= Geomorphologische Karte 1 : 25 000 der Bundesrepublik Deutschland) befolgt diese Prinzipien.

La carte géomorphologique de la République Fédérale d'Allemagne au 1:25 000 dans le cadre internationale du developpement de la cartographie géomorphologique

R é s u m é: La cartographie géomorphologique moderne commence avec le "Meßtischblatt Stadtremda" de S. PASSARGE. Depuis, de nombreuses méthodes ont été élaborées. Elles ont abouti au raffinement du fond et de la forme des cartes géomorphologiques à grande échelle, mais elles n'ont rien changé au principe. Les cartes mettant l'accent sur la géomorphogenèse étaient au premier plan, mais elles s'écartaient des principes de S. PASSARGE, ce qui a entrainé une certaine indifférence pour les cartes géomorphologiques. Plus tard, la méthode H. KUGLER et le système ITC ont recréé la carte géomorphologique moderne.

Elle doit être à la fois à grande échelle quantitative, ainsi qu'applicable à des buts pratiques. Ceci demande un système d'assemblage par éléments pour les informations de la carte. La GMK 25 BRD (= Carte géomorphologique 1:25 000 de la République Fédérale d'Allemagne) est établie selon ces principes.

C o n t e n s:

1. Development of the geomorphological cartography since 1900

A short summary will show that "real" geomorphological maps were designed soon after the year 1900. The author deliberately presents only a selection of examples and does not aspire to any completeness. For this purpose a lot of references to books and papers are made in this paper.

1.1 Historical development

The "Meßtischblatt Stadtremda" (plane survey sheet Stadtremda) by PASSARGE (1914) was an early landmark in the history of the geomorphological mapping. This geomorpholgical map 1:25 000 presented geomorphological and geomorphodynamic facts by means of a multiple sheet system. Compared with PASSARGE all other attempts did not show any methodical progress until in the middle of the fourties.[1]

It was only after some decades that various Swiss geomorphological maps induced new impulses. Their principles are presented by ANNAHEIM (1956). The geomorphological signs were classified into erosion processes and accumulation processes - a procedure which enlarged the manner of representation. But this method had no regard to the polygenesis of the relief forms. In particular Polish mapping methods stimulated the development of the geomorphological mapping in the socialistic countries. A summary of all these signs can be found in the paper of KLIMASZEWSKI (1963). Until then these geomorphological maps had several information layers and the soil material was considered to be more and more important. At the same time a method was designed which was used by TRICART (1959) and his assistants for practical purposes in developing countries. TRICART et al. (1972) discusses the variety of the geomorphological mapping systems in his book "cartographie géomorphologique". Nevertheless other western-European countries developed their own systems. The Belgian mapping system (GULLENTOPS 1964) and the ITC system (Delft resp. Enschede Netherlands) are based on PASSARGEs mapping system. The ITC system was presented by VERSTAPPEN & VAN ZUIDAM (1968). Besides a second mapping system was designed for Dutch purposes, which emphasized the genesis of the soil material and combined it with a geomorphographic representation of the relief (TEN CATE & MAARLEVELD 1977).

[1] This is discussed extensively in LESER (1967) where the further development is shown, too. A scientific-historical summary can be found in SPIRIDONOW (1956, 1975) and TRICART et al. (1972).

Two special systems have to be mentioned, too: The "commission for geomorphological survey and mapping" of the IGU developed a combined representation system for complex geomorphological maps at the scales 1: 25 000 and 1:50 000 (BASHENINA et al. 1968). But this method had no international success. Another system was developed by KUGLER (1964, 1965). This method is based on a brick-system which is its most important feature, and which allows numerous ways of interpretation of the different information layers. Besides this legend can be used for different scales (KUGLER 1968,1974).

1.2 Aims of geomorphological maps at large scales and their changes in time

For a long time the main interest has been a geomorphogenetical one. Nevertheless an interesting alteration of the contents of geomorphological maps at large scales took place. Although the geomorphographic relief signs have not changed for decades - they only varied the same sign complexe again and again - a more and more quantitative representation of the geomorphological forms had been aspired. This is shown especially by Belgian, Dutch and German maps (VANMAERCKE-GOTTIGNY 1967, DE LANGE & TEN CATE 1980, KUGLER 1964, 1974). Besides these maps represent the soil-material in a very differentiated way. Respecting contents as well as graphical representation the Belgian and the German maps separate clearly the different information layers which facilitates the interpretation of these maps for practical purposes. But some French maps, too, show a differentiated representation of the soil material.

The geomorphogenetic contents have changed most within the years. Only a few mapping methods represent the geomorphogenesis on a separated sheet (KUGLER 1965, VERSTAPPEN 1970). Most mapping systems, however, combine the representation of the geomorphogenesis with various information layers. But this integration makes the interpretation and application of geomorphological maps more difficult, in particular for all non-geomorphologists. Moreover there are also mapping systems which consider the geomorphogenesis to be the most important subject of a geomorphological map. The "periglacial-geomorphological maps" (POSER 1953 ff.) are an example for this kind of geomorphological mapping systems. It is obvious that the integration of the geomorphogenesis was always a problem - respecting contents as well as its presentation - which has not been satisfactory solved yet.

To sum up: The aim of most of the geomorphological mapping systems was a complexe geomorphological map. Its contents became more and more differentiated, but the interpretation and the application of these maps were not simplified. All mapping systems which represent - in an isolated or combined manner - geomorphological partial subjects were laid by. Today the complex geomorphological map on a large scale is considered to be the final product of this alteration process.

2. Outlines and main features of the GMK 25 BRD[2] in comparison with other mapping systems

Outlines and characteristic features of the GMK 25 BRD (LESER & STÄBLEIN 1975, 1980) are presented in another paper in this volume. In this paper the outlines of the GMK 25 BRD shall be compared with other mapping systems, especially with older ones, on which the GMK 25 BRD is based. Their geomorphographic basic features follows the example of KUGLER (1964, 1965, 1974). The geomorphogenetic situations refer to the principles of the French system (TRICART 1972) and the IGU system (BASHENINA et al. 1968). The representation of the soil material is based on the method of KUGLER (1964) which is also used - partly modified, partly in its original form - on several, but not on all French maps. The various mapping systems have been compared one with another for several times (GILEWSKA 1967, VAN DORSSER & SALOME 1973, 1974, SALOME & VAN DORSSER 1982). This comparisons showed that a revival of contents and formalities is possible and necessary even on the complex geomorphological maps on large scales.

The inventory of the geomorphological mapping in the Federal Republic of Germany (LESER 1968, 1974) showed that there is - compared with the international development - a backlog demand. But the numerous geomorphological maps which have been edited in the Federal Republic of Germany until the beginning of the seventies did not follow the international discussion and their resulting outlines. Several predecessors of the GMK 25 BRD made attempts to eliminate these deficits (GÖBEL 1978 a, b, LESER 1975, 1983, WERNER 1977), but it had not any success until the GMK 25 BRD was created by means of the DFG-priority-programme (BARSCH 1976, LESER 1976).

2.1 Problems of scale and interpretation feasibilities

The scale 1:25 000 of the GMK 25 BRD is one of the most frequently used scales of the German geoscientific maps (BK 25, GK 25[3]). This scale depends on the one of the traditional plane survey sheets (TK 25[4]) which are available for the whole country. An international comparison of geomorphological maps shows, that the scales 1:25 000 and 1:50 000 are generally used. This is caused by the basic-maps which are available as well as by aim and purpose of these maps. The authors of these maps at both scales 1:25 000 and 1:50 000 emphasize the large application field. But this mentioned application is only possible within certain scientific scopes and only with certain information layers (see 2.2 and 3.). This problem was discussed by KUGLER (1965), LESER (1980) and BARSCH & MÄUSBACHER (1979). Concerning special geomorphological

[2] GMK 25 BRD = Geomorphologische Karte 1 : 25 000 der Bundesrepublik Deutschland (= Geomorphological Map 1 : 25 000 of the Federal Republic of Germany).

[3] BK 25 = Bodenkundliche Karte 1 : 25 000 (= Pedological Map 1 : 25 000); GK 25 = Geologische Karte 1 : 25 000 (=Geological Map 1 : 25 000).

[4] TK 25 = Topographische Karte 1 : 25 000 (=Topographical Map 1 : 25 000).

purposes the scales 1:25 000 and 1:50 000 are satisfactory ones.

Another problem of the relatively large scale 1:25 000 is the problem of generalisation. VERSTAPPEN (1970) showed how to generalize the ITC system. KUGLER (1968) proved that this mapping system was transferable into other smaller scales. To enable this generalisation he developed suitable principles adapted to his system. - Although no attempt to generalize the GMK 25 BRD has been made this would be possible thanks to the strict organization of the system into single information layers. The GMK 100 (FRÄNZLE et al. 1979) which is in preparation goes in this direction. Nevertheless the practical experiences proved that the "Grüne Legende" (LESER & STÄBLEIN 1975, 1980) can also be used without any big problems for mapping on larger scales, e.g. 1:5 000 and 1:10 000. Thanks to the brick-system situation which cannot be generalized can be given up for the generalization process without causing problems of contents. Besides a generalization may emphasize and clarify certain contents for special purposes.

2.2 Emphasis of content and problems of representation

The GMK 25 BRD is a complex geomorphological map. Its aim is the comprehensive representation of the georelief and its various marginal conditions, e.g. hydrology or soil material. As a result of the aims of the GMK 25 BRD which is a complete geomorphographic characterisation of the georelief (singular landforms, slope angles, roughness, elements of the relief), the geomorphological map shows plenty of geomorphographic informations. They are arranged visually in spatial patterns which explain themselves or whose singular contents elements are identifiable or explainable by the arrangement of signs and forms. Such a rich geomorphographic information layer can only be found on the maps of KUGLER (1964, 1965, 1968, 1974) resp. on the precursors of the GMK 25 BRD (GÖBEL 1978 a, b, LESER 1975, WERNER 1977). The Belgian geomorphological maps which offer rich geomorphographic informations distinguish themselves - compared with the GMK 25 BRD - by a clearer cartographic representation which is the result of another kind of depiction of the slope angles. The slope angles are shown on the GMK 25 BRD by means of a spatial raster, a method which proves to burden the sheets of the GMK 25 BRD. Another solutuion of the problem of the representation of the slope angles must be found in the future. KUGLER solved this problem by means of a multiple sheet system[5] which should be favoured henceforth because of the better interpretation feasibilities for practical purpose.. All other mapping systems which are single sheet systems, as it is the GMK 25 BRD, too, dispense with the spatial representation of the slope angles. Besides the information layer "geomorphography" of plenty of these maps is very poor which is an unsatisfactory solution from the scientific as well as from the practical point of view.

A second emphasis of content is the presentation of the geomorphogenetic situation which follows the examples of various predecessors (IGU system, system TRICART et al.) and favours the colour. Thus the contents of the map gets a certain classification and structure. The GMK 25 BRD is intended to be a manual map. Thanks to the coloured areas it has a distant effect and gives the impression of being clearly arranged. Indeed there is only an indirect connection between the coloured, mostly bigger areas of processes and the other information layers which show a better differentiation of the contents than the coloured process-areas.

In its outward appearance the GMK 25 BRD resembles various other mapping systems. Nevertheless there are some differencies: it is highly differentiated and shows a rich abundance of non-geomorphgenetic contents. Thus it seems to be an obvious conclusion that the colour is the best mean to represent clearly this wealth of contents. This does not fit because the outlines of this mapping system are based on the traditional ideas of German geomorphlogy which is mainly interested in the geomorphogenetic processes and situation. As it is known the geomorphogenetic contents of the geomorphological maps are claims of geomorphological theories which are presented graphically. Therefore a relatively uncertain element would be emphasized in an unjustified manner. This is also valid for other mapping systems, e.g. the various versions of the system of TRICART or the geomorphological representation systems of socialistic countries. This visual overestimation of the geomorphogenesis can only be avoided (on the GMK 25 BRD as well as on the maps of other national systems) provided that a multiple sheet system is aspired to, as it is realised by the ITC system (VERSTAPPEN 1970) or the system of KUGLER (1965). Some practical hints can also be found in PASSARGE (1914).

2.3 Emphasis of statements of the various geomorphological mapping systems

All mentioned mapping systems concentrate on certain statements. It is obvious that they can be repre-

5 On the KUGLER-maps the areas of slope angles are represented spatially by colours.

sented easier if the map is designed as a multiple sheet system. The most consistent systems are those of KUGLER (1964, 1965, 1968, 1974) and the ITC system (VERSTAPPEN 1970, VERSTAPPEN & VAN ZUIDAM 1968). Therefore these methods do not show any essential graphic overlaps of their contents. Besides the interpretations for practical purposes are made easier.

Most of the mentioned mapping systems are particularly interested in the geomorphogenetic situation though it is not always expressed graphically. All these mapping systems claim to supply data which can be used for practical purposes. A claim which is only partly accomplished (see 3.). To stand out from these mapping systems was one of the aims of the GMK 25 BRD. Concerning the contents the GMK 25 BRD is surely successful in delivering statements which are practically applicable, as far as it is possible within the scale 1:25 000.[6] Concerning the graphical presentation (for technical aspects see 4.) the GMK 25 BRD is only partly successful. The reason for this is the use of the colour to represent the geomorphogenetic situation. As a result of this the numerous geomorphographic and current geomorphodynamic facts of the other information layers do not find clear expressions.

Compared with the complex geomorphological maps (type IGU-system, type method TRICART or type GMK 50 NL[7]) the GMK 25 BRD, however, represents clearly and in a more differentiated way the proper subject of geomorphological maps: the georelief, represented by its soil material. This is also proved by a comparison between the sheets of the GMK 25 BRD and the map extracts which was made by GILEWSKA (1967), VAN DORSSER & SALOME (1973, 1974) and SALOME, VAN DORSSER & RIEFF (1982). Provided that the GMK 25 BRD were designed as a multiple sheet system it could outdo the contents of the ITC maps and catch up with the maps of KUGLER.

To sum up: there are no ideal outlines for a complex GMK 25 at a large scale. All mapping systems of complex geomorphological maps must make concessions to the differentiation of its contents or to their representation. It is obvious that the representation problems of complex geomorphological maps at large scales can only be avoided if a multiple sheet system is aspired to.

3. Position of the GMK 25 BRD in the international framework with a view to interpretation and application

Almost all authors of maps emphasize the good application feasibility of their mapping system. Indeed especially the system TRICART and the ITC system very often found practical applications. This is partly true, too, for numerous unpublished geomorphological maps at large scales of socialistic countries. But this application of geomorphological maps took place under special circumstances, that means because pedological and geological maps were not available or because special informations were required. Complex geomorphological maps were only used, in some exceptions, to solve geoecological or planning problems.

The GMK 25 BRD and its outlines are neither better nor worse applicable than other geomorphological maps. It has similar or the same contents and the same scale. Thus the problems of practical applications are the same. It is clear that the reasons for these problems are not only contents and forms of geomorphological maps, but many of these problems are caused by the persons who use them. The difficulties are a result of a geoscientific minimal knowledge of many practicians. That is why not only geomorphological maps but also other geoscientific maps have the same difficulties of application.

The GMK 25 BRD was only designed after the development of numerous other mapping systems of which already some maps existed. Thus the GMK 25 BRD had everything to gain regarding to the experiences of other maps on the fields of design, cartography and application. Two important consequences resulted from the experiences: 1. the consistent use of the brick-system to represent forms and 2. the strict separation of the different information layers of the GMK 25 BRD. To make application and interpretation easier geomorphologische Auszugskar-

6 This was discussed by LESER (1980).

7 GMK 50 NL = Geomorphologische Karte 1 : 50 000 der Niederlande (= Geomorphological Map 1 : 50 000 of the Netherlands).

ten (geomorphological derivative maps = cartes géomorphologiques dérivées) can be made. These are the technical singular prints of the various information layers. They are producable as single or combined sheets out of the existing printing plates. That is one of the principal differences between GMK 25 BRD and the other geomorphological maps at the same scale of which such separated prints are not available because of technical and methodical reasons. Besides the realtively poor contents of those maps would made visible. Only the method of KUGLER is an exception which provides the same method and which shows a similar or the same amount of details as the GMK 25 BRD does.

The Auswertungskarten (=interpretation maps = cartes d'interprétation) must be mentioned, too. It is a new thematical map which was developed on the basis of the complex GMK 25. Nevertheless there is a second difference between the GMK 25 BRD and the other geomorphological maps of the same scale. The contents of the GMK 25 BRD can be interpreted in a wider and more differentiated way than the other geomorphological maps whose contents are poorer.

4. Position of the cartographic presentation of the GMK 25 BRD in the international framework

The development of geomorphological maps at large scales took place (see 1.) in the course of eight decades. In this epoch the technology of production and printing of maps was modified, a change of which the representation of geomorphological maps at large scale could profit. Despite the multiple sheet system the maps of PASSARGE (1914) seem to be very simple. The French maps show very often a rough drawing and too much graphic details which are hard to read. Even the maps of KUGLER show sometimes coarse features, because it is obvious that printing technology and paper quality limited the printing quality. From the printing and graphic point of view very good maps are the Belgian ones (FOURNEAU 1966, VANMAERCKE-GOTTIGNY 1967) and the Dutch ones (DE LANGE & TEN CATE 1980). Especially the GMK 50 NL brought new high standards with its highly differentiated contents, the large size and the perfect polychromy, standards which the other maps of other countries could not achieve. Besides the GMK 50 NL is a series of maps which is published successively and its aim was to achieve a high technical standard from the very beginning. Many geomorphological maps of other countries are only represented by singular sheets which often show cartographical trial printings. It is a pity that the geomorphological maps 1:25 000 and 1:50 000 of several socialistic countries have not been published yet, that is why we cannot compare them with the GMK 25 BRD. France, too, published GMK 25 F[8] (CNRS 1976 ff., only one sheet published) and two GMK 50 F[9] (ANG 1969 ff., three sheets published concerning the Normandy only; CNRS 1972 ff., ten sheets published), but their technical production is similar to the other geomorphological maps.

The two real predecessors of the GMK 25 BRD (GÖBEL 1978 a, b, WERNER 1977) brought the first new cartographic standards. The TK 25 BRD served as a basis on which the contents of the GMK 25 were projected. This was a first elimination of the partly very bad topographic basis of a lot of geomorphological maps whose geomorphological contents could not be interpreted because of a lacking topographic basis. The polychromy was used further on as well as the clearly drawn geomorphology signs. Thus it was possible to unite numerous contents on one map without overloading it graphically.

It was obvious that the GMK 25 BRD had to achieve those high standards of geoscientific map production represented - for many decades - by the BK 25 BRD and the GK 25 BRD. Both predecessors of the GMK 25 BRD showed that the geomorphological map was much richer than the BK 25 and GK 25 and could achieve a pretty high graphic standard and a high esthetical level. That required a professional map production. The only institution which met these most exating demands was the Institut für Angewandte Geodäsie in Berlin (= IFAG = Institut for Applied Geodesy, Berlin) where drawing and printing of the maps were done. The high cartographic and typographic standard is called "GMK-Norm". This

[8] GMK 25 F = Geomorphologische Karte 1: 25 000 von Frankreich (= Geomorphological Map 1 : 25 000 of France = Carte géomophologique 1 : 25 000 de la France).

[9] GMK 50 F = Geomorphologische Detailkarte 1 : 50 000 von Frankreich (= Detailed Geomorphological Map 1 : 50 000 of France = Carte géomorphologique détaillée 1 : 50 000 de la France).

procedure implies that while drawing the clean field map several working steps have to be adapted and the drafts agree with the GMK-Norm. It turned out that drawing, reproduction graphics and printing of the maps are faciliated by splitting up the contents into various separated information layers.

The comparison of the quality of printing and production of the various geomorphological maps show that the GMK-Norm of the GMK 25 BRD sets a new level. Even those sheets of the GMK 25 BRD which are very rich in contents are easy to read owing to the neat drawing and the accurate printing of these maps. Thus this high technical level improves the scientific quality of these maps. All sheets of the GMK 25 BRD gain by high technical standard of cartography and map printing. Nevertheless these technical high levels are not their only mark of quality. The scientific quality is also caused by the brick-system and the outlines of the information layers which enabled the production of geomorphological maps which may also gain a good reputation outside Western Germany. Besides the GMK 25 BRD completed the geoscientific "map family" of the BK 25 BRD and the GK 25 BRD.

It is obvious that there are geomorphological maps which satisfy esthetically more than the sheets of the GMK 25 BRD, e.g. the map of the Lancer area, Saskatchewan (SAINT-ONGE 1966). But this visual effect may not be the only criterion of the quality of a geomorphological map at large scale. Its aim is to fulfill different purposes. That means not only esthetical ones but also scientific and practical purposes. That is the reason why each geomorphological map at a large scale is a compromise especially if it is a one sheet system. Compared with the maps of this mentioned system the GMK 25 BRD seems to be the most favourable compromise, because its qualities of contents are proven. Its contents are interpretable directly or indirectly for geomorphological, geoscientific and various practical purposes. Only a few other geomorphological maps at the same scale have these extensive feasibilities of interpretation, too, which are caused by the high level of scientific and cartographic treatment of these sheets.

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The "Königssee" sheet of the 1 : 25 000 geomorphological mapping (GMK 25) of the Federal Republic of Germany

with 1 figure and 1 map as supplement

KLAUS FISCHER

A b s t r a c t: The "Königssee" map sheet covers a section of the Northern Limestone High Alps. The present large-scale morphological features of the area's high alpine topography are determined by petrographic and tectonic characteristics, as well as influences of a fossil relief. High alpine features and the prevailing of limestones dominate the present-day morphological processes of all scales, above all those of gravitational and corrosive nature.

Das Blatt Königssee der Geomorphologischen Karte 1 : 25 000 (GMK 25) der Bundesrepublik Deutschland .

K u r z f a s s u n g: Das Blatt Königssee umfaßt einen Ausschnitt aus den nördlichen Kalkhochalpen. Die Großformen des heutigen Hochgebirges im Blattgebiet sind in ihrer Anlage auf den Gesteinsbestand, die Tektonik und auf vorzeitliche Reliefeinflüsse zurückzuführen. Hochgebirgsformen und die unter den Gesteinen dominierenden Kalke bestimmen das aktuelle Prozeßgeschehen und die Kleinformenbildung, nämlich gravitative und korrosive Vorgänge.

La feuille "Königssee" de la carte géomorphologique 1 : 25 000 (GMK 25) de la République Fédérale d'Allemagne

R é s u m é: La feuille Königssee représente une région située dans la partie septentrionale des hautes Alpes calcaires. La pétrographie, la tectonique et l'influence du relief pré-glaciaire sont déterminants pour la morphologie générale actuelle de la montagne. Les roches calcaires dominantes et les formes de haute montagne induisent l'évolution morphologique actuelle et le modelé de détail, notamment les processus gravitationels et de corrosion.

C o n t e n t s

1. General geomorphological characteristics and geological outline of the area

Situated in the very southeastern corner of the Federal Republic of Germany, the "Königssee" sheet of the GMK 25 covers a part of the Northern Limestone Alps. It is in this area that the two basic types of mountain relief characteristic of the Northern Limestone Alps meet - i.e. the chain type on the one, the plateau type on the other hand. West of the area covered, we find the chain type predominant in the groups of the Wilder Kaiser, the Karwendel, the

I am grateful to Mr. Thomas Schneider of my staff for translating this article.

Wetterstein, the Mieming, as well as the Lechtal and Allgäu mountains; these are characterized by sharp ridges and arêtes and sometimes deeply-incised notches.

The individual groups are separated by longitudinal valleys which follow deformed synclines or less resistant strata. With the Berchtesgaden Alps, around the Königssee lake in their centre, and from there on eastward, it is the second type which becomes predominant - mountains flanked by steep and high cliffs uniformly rising up from the valleys, their high regions having a plateau-like shape. This applies to the groups of the Hagengebirge, the Tennengebirge, the Dachstein, the Totes Gebirge, as well as others further east.

It must be noted that the term 'plateau', in this context, is not to be understood in the sense of an actual plain; it can rather be described as a topography of moderately convex, or hilly forms which sharply contrast with the steep drop down to the surrounding valleys.

Thus, this "stock" type of mountains has some resemblance to a molar tooth. These differences in geomorphological shape are caused by different geological structures. In that part of the Limestone High Alps where the chain type is predominant, the relief is determined, in most places, by intensive folding with steeply tilted strata of varying dip, caused by the overthrust, piling-up and intertwining of nappes of sedimentary rock (mainly limestones and dolomites). On the other hand the plateau type is dependent on horizontal or only slightly inclined thick strata of limestone, which were also moved in nappes, but only horizontally, and without undergoing appreciable folding. However, after reaching the position in which they are now they were subject to faulting as a consequence of differentiated vertical tectonic movements resulting in faults with a steep to vertical dip. Later these limestones underwent intensive karstification.

On the Königssee sheet, the Hochkalter and the Watzmann group represent the chain type of mountains. Their shape is caused by the fact that particularly high uplifting affected both of these groups and, above all, by the marked dip of the sedimentary strata towards the North and Northeast (exceeding 30^{o} in most places). In contrast to that, the groups of the Seehorn and Hundstod, the Simetsberg with the area east of it, and, east of the Königssee, the Gotzen area, show the southern part of the map sheet to be constituted of the plateau type. This part is mainly built up by finely fissured dolomites ("Ramsaudolomit" and Carnian-Norian dolomite), forming the base and, overlying the former, horizontal to slightly dipping strata of extraordinarily pure limestone ("Dachsteinkalk"). This accounts for the development of impressive karst phenomena in connection with an almost complete lack of surface drainage. Thus, stratigraphic and petrographic characteristics have played a decisive role in shaping this landscape to its present form. Valley density is very low in the regions of the great karst stocks. Yet there are, as typical features, a few transverse valleys which reach back quite a long way into the karst stocks and end in a kind of dead-end, such as the depression of the Königssee and Obersee (the dead-end lying east of the map border). Because of their reaching back into the karst stocks they are usually referred to as "Karstsacktäler" (dead-end karst valleys), though originally they had very little to do with karstification; it is rather the glacial erosion of the Pleistocene which formed them into troughs.

2. The influence of tectonics and petrological characteristics on landforms and their shaping

Tectonic lines and borders as well as the variety of geological material, with all the rocks having a specific resistance to weathering, are of great influence on the shaping of the landforms. Thus, the Klausbach valley in the northwestern corner of the sheet has developed exactly where the Tirolian unit (or "nappe"), to which most of the map sheet belongs, dips north, bordering on the Reiteralm nappe. Further examples are the descents of the Hochkalter and Watzmann groups on their northern and northwestern side, which more or less follow the inclination of the strata of this tectonic unit. The development of step faults has rendered the situation even more complicated. An exceptionally fine example for this is the course of the crest on the northern side of the Hochkalter group, which from the Hochkalter peak (2607 m) runs north to the Schärtenwand, and from there to the Blaueisspitze (2481 m), the trigonometrical point 2012 (northeast of the Blaueisspitze; no altitude given on the map), the Stanglahnerkopf, and the Kitzkartauern.

The Kesselbach ravine with the Kesselwand cliff (E 4575, N 5270) indicate an important tectonic fracture zone which is continued across the Königssee through the Eisgraben ravine, the Hocheis, and the Banngraben as far as the upper Wimbachtal. The latter also gives evidence of tectonic influences, as it has developed exactly in the vertex of a big anticline traversed by many minor fault lines. It is also to be supposed that the forming of the Königssee trough was influenced by the presence of fault lines. In any case, the course of the Königssee depression is continued towards the south by the "Sagereck" fault line which separated the higher block of the Simetsberg in the west (tectonically lifted) from the lower block around the Sagereck Alm, the Halsgrube, and the Schwarzensee in the east; another uplifted block is again represented by that of the Moosscheibe and Kuhscheibe further east.

A more detailed discussion would show the whole area to be criscrossed by a great number of additional fault lines, the main direction of which is 0 to 40°, and 90 to 120°. As was already pointed out with the Hochkalter, most of them are of considerable geomorphological significance. The Wimbachtal valley gives many striking examples for that; ravines and recesses following fault lines occur as well on the western side (Hochkalter group) as, continuing them, on the eastern side (Watzmann group). One fault running from the gap of the Hochalmscharte (Hochkalter) to the Schüttalpschneid (Watzmann) shows a throw of 500 meters; another example is the one from the Schneelahnergraben (Hochkalter) to the Hochgraben (Watzmann), and the gap of the Sittersbachscharte and the Mittergraben ravine also follow a fault line. The large karst hollow around the Grünsee has also developed as a consequence of a fault zone of the afore-mentioned strike. Other faults have resulted in the development of the "Saugasse" depression where impressive slickensides can still be seen, and in the abrupt drop between the parts east and west of a line running between the Mausalpeck and the trigonometrical point 1444 (south of the Eisgraben). Just as most gaps in the crests, most rockfall chutes and avalanche channels, chimneys and joints in the cliffs occur as a consequence of fault lines, the same applies to Karstgassen ("karst lanes" - straight and extremely widened passages of great length), chains of dolines and shafts, and the course of caves in karstified areas. All those examples give evidence of the decisive impact of structural characteristics on the present relief in our area.

Besides those structural characteristics, it is the petrographic factor which has a major influence on the geomorphological features of the landscape on our sheet (Fig. 1). Above all, there are two kinds of rock which have to be mentioned - the "Raumsaudolomit" (Anisian-Ladinian) together with the dolomite of Karnian-Norian age, and the "Dachsteinkalk" (Norian limestone); together they can reach more than 2000 m in thickness. The Dachsteinkalk is a very compact and extraordinarily pure, light-grey to whitish species of limestone, which may also show a yellowish or reddish colour when weathering. As a rule it contains few cataclastic structures, which is one of the reasons why it tends to form high and steep cliffs as a consequence of valley incision. In fact, all the high cliffs on the map sheet have developed in Dachsteinkalk, including the famous east drop of the Watzmann. They are all, with only a few exceptions, characterized by distinct beds over many hundreds of meters in height. This stratigraphic feature ist caused by the development of so-called "Loferites", (the word is derived from the nearby "Loferer Steinberge" group), i.e. an alternation between mighty strata of limestones and breccias, or dolomitic layers of stromatholite originating in densely-growing algae. As the material shows very little jointing it possesses great resistance to weathering. This also results in the fact that, with the exception of only a few special cases, only small debris cones can be found at the foot of Dachsteinkalk cliffs. What's more, geomorphological features, once formed, are preserved from destruction for a long period. The latter can be

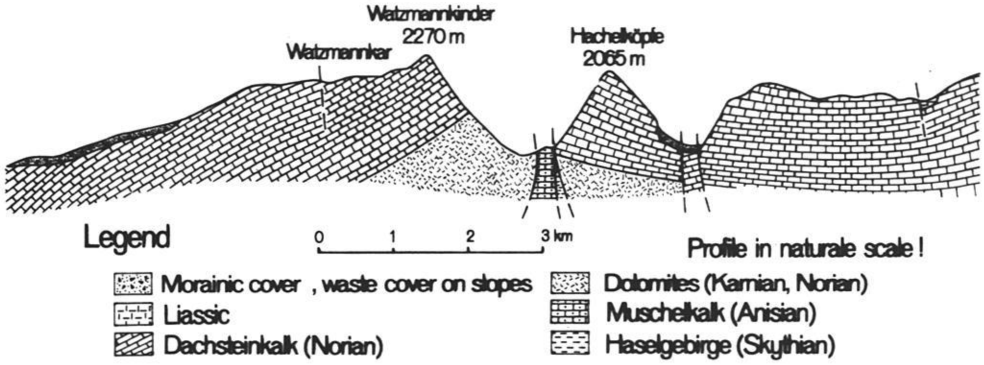

Fig. 1: Geological profile

illustrated expecially well by the trough forms of the Blaueistal, the Ofental, and the Steintal.

The exceptional purity of the limestone, together with its horizontal to slightly tilted bedding, has caused a karst relief of great variety to develop. A significant feature of this relief, as indeed of large parts of the "Königssee" sheet, is an almost complete lack of surface water. Very little is known so far about the karst hydrology of the Berchtesgaden Alps . Anyway, it may be assumed that considerable parts are tributary to the Königssee lake, which reaches a sizeable 190 m in depth. Belonging to a lower stratigraphic position, the dolomites ("Ramsaudolomit", Karnian-Norian dolomite) form the base underlying the limestone stocks. They rarely show any bedding, and the whitish to gray material shows excessive jointing, which makes it fissure and disintegrate through weathering or mechanical stress down to particles of pebble size. Thus it yields great quantities of gravelly debris from the above-mentioned pebble to cobble and boulder size, which has been called "Gries" from early days.

As a consequence of the enormous masses of debris yielded by the weathering of the dolomites, those areas show impressive examples of valley filling, the largest one of the whole Bavarian Alps being that in the Wimbachgries. Another example can be found in the Hochwies. The mountain flanks made up of dolomites are notched with numerous branching rills and gullies, cliffs and walls are interspersed with chimneys and chutes; the rock surface is thus often reduced to scars, crags and pinnacles, changing its aspect within comparatively short periods. The continuous destruction is documented by creviced towers, pillars, pinnacles and needles, crenellating the ridges - a characteristic feature of all the mountains enclosing the Inner Wimbachgries, the sack-like extension of which towards the south has been caused to a large extent by these processes. Other kinds of rocks occupy only very limited areas of the Königssee sheet, and are therefore of minor importance as to their geomorphological relevance. The only ones worth noting are those of Liassic and Dogger age. These easily strike the eye, partly because of their reddish colours, and partly because they weather into clayey residual material. They are a bit more widespread in the Kitzkartauern and the Roint area (Kühroint, Herrenroint), as well as around the Gotzenalm; reddish limestones of that age have undergone intensive karstification in the Grünsee and Schwarzensee area.

3. The influence of a fossil relief and the shaping of the landscape

The karstification of the limestone produced favorable conditions for the preservation of older forms up to our days. It meant a general decrease of erosion by an increasing protection of the surface against fluvial influences. However, for the above-mentioned reasons there are no traces of a fossil relief to be found in the high regions of the chain type mountains (Watzmann and Hochkalter group), which have undergone especially marked uplifting; those traces may not have been preserved, or perhaps there never were any. Anyway, they do cover large areas in the southern part of the map sheet, showing forms which rather resemble a lower mountainous or even hilly landscape, than a high mountainous relief. Only a few individual summits, like the Großer Hundstod (2593 m) rise above this fossil relief as veritable high alpine forms. The remains of a fossil relief do not occur on one single level only, but are distributed vertically over a range of several hundred meters (from 1500 to 2300 m).

These discrepancies in altitude between such neighbouring parts of a gentler relief have led to different conclusions as to their origin. It has been claimed on the one side that they all originated in a single homogeneous landscape, thus being of the same age, and were brought into their present position by a deformation of this old landscape, or even its disintegration along faults (MACHATSCHEK 1922, LICHTENECKER 1938). However, this view has been contradicted by others arguing that no correlation could be established between the parts of relief in question and their assumed delimitations, and the local geological structures; at all events it would be fault scarps that were developed. For example, the Scheibenwand (in the southeast corner of the map) is interpreted as such a fault scarp, continuing further south (outside the map sheet) with the Stuhlwand with heights up to 400 m. Yet the differences of resistance between the Red Liassic limestones and the adjoining Dachsteinkalk in this part are not significant enough to completely account for the heights of these walls. So, on the other hand, a second interpretation is based on the view that old landscapes of different ages, which developed successively, were fitted into one another, thus forming a series of piedmont steps.

According to this system the Schneiber ridge (about 2200 to 2390 m) would be an element of the oldest landscape reconstructable. Below that, from the Rotleitenschneid (2290 m) to the Hundstodgatterl (2188 m), and on to the area around the "Ingolstädter Haus" refuge and south of the Kuhscheibe (near the southern border of the map, between E 4573 and 4574) would represent a landscape of a lower level. Still lower would be the remains of a third landscape - around the Trischübel-Alm, around the Seehorn in the "Platteret" area west of the Ingolstädter Haus, around the Grenzköpfe and Schönbichl-Alm, at the Simetsberg, at the Moosscheibe, and around the Gotzen-Alm and the Klausbergl east of the Königssee.

However, there does not seem to be enough evidence, or necessity, for differentiating the present relief of the higher regions into three such generations of landscapes. So, for Example, LEIDLMAIR (1956) proceeded to combine the two older and higher landscapes into one. In any case, a clear distinction between these old landscapes is very difficult in nature, expecially if the locally differentiated extent of glacial erosion is to be taken into consideration.

Depressions and valleys, which are often stepped, reach back from the north and west into the higher regions and their old landscapes. The most important ones among them are the Dießbachtal together with the Hochwies in the southwest, the Wimbachtal, and the depression of the Königssee which is continued along the Schrainbachtal and the Saugasse to the Funtensee (outside the map sheet), and over the area around the Sagereck-Alm to the Grünsee. There are sections with markedly gentler gradients along the flanks of these valleys - ledges and benches, which can be connected, thus representing remnants of different valley generations. So far, four valley generations have been established in general concurrence in the Berchtesgaden Alps, but a classification of their respective age is yet uncertain. Anyway, there are not enough remains of them within the area covered by our map sheet to allow any confirmation, or correction, of such a classification. However, there are well-preserved remains of a flatter topography around the areas of the Kühroint-Alm, the Archenkopf and the Sommerbichl, as well as, east of the Königssee, in the Büchsenkopf area (N 5270 to 71), or around the Seeau-Alm. The existence of stepped valley floors and benched valley flanks in this area is generally regarded as the result of an intermittent uplift; only few authors have interpreted these phenomena as caused by a climatic-geomorphological change taking place between the Upper Miocene and the Late Pliocene. The fossil landscapes in the higher regions above 2000 m are also put down to considerable uplift by most authors.

This view is supported by the fact that a great number of big cave systems developed in the limestone stocks show a repeated change of horizontal and vertical passages, the latter covering up to several hundred meters in height, which suggests significant changes in the level of the corresponding drainage system. However, a closer examination into these problems has been lacking so far. On the whole, the shaping of the relief between the Upper Miocene and the Pre-Glacial led to an intensified emerging of convex forms, to a general decrease in valley width along with stronger valley incision, and, as will be shown further down, to a growing relevance of petrographic factors for the geomorphologic development. Generally speaking, the sculptural relief has gained in accentuation over this period.

During the Pleistocene this landscape was subject to great glacial influences. Cirques developed on the flanks of the higher elevations, like the Großer Hundstod or the Schneiber (east side), and the valley heads were changed into cirques. This is especially conspicuous in the model forms of the Hochkalter group. In the Watzmann group, the Watzmannkar and the Watzmanngrube, as well as the entire catchment area of the Eiskapelle, comprising also the Watzmann east flank, can be called a "Großkar" (large cirque), as a veritable floor, or a cirque threshold, are lacking in all of them, or have been covered by debris. Slopes were steepened into walls, and the fossil landscapes were modified to form expansive areas of "Rundbuckel" (nobs, roches moutonées) or "Schichttreppenkarst" (karstified stepped outcrops of horizontal limestone strata). The same applies to the extreme southern part of the map sheet, which was covered by the Steinernes Meer plateau glacier; here, the relief was by no means preserved by the ice cover, but rather eroded considerably. This is proved by numerous remains of caves produced by glacial erosion, namely topping from above or lateral cutting. This is quite obvious if one bears in mind the thickness of the ice cover reaching up to 350 m, which can be deduced from traces of glacial scouring along the valley sides. It is especially in the Schneiber and Kleiner Hundstod area that such "cave ruins" appear.

Not least, glacial erosion widened and deepened the valleys at the cost of mountains flanking them (oversteepening, overdeepening); this resulted in impressive precipices, like the one between the sharply-pointed Hachelköpfe and the overdeepened Eisgraben. The pre-glacial valley floor of the Königssee depression was eroded by 350 to 400 m, and on top of that the bottom of the present lake was overdeepened by an additional minimum of 200 m. The same applies to the Wimbachtal which underwent considerable incision and, in parts, overdeepening. The surface of the solid rock lies up to 350 m below the present bottom of the valley which is formed by sediments. The results of refraction-seismic and geo-electric measurements have shown that below the late- and post-glacial debris, glacially compacted sediments cover the solid rock surface. This could mean that the greatest rates of glacial erosion and widening were reached during pre-Würmian glaciations. The same would apply to the modification of valleys into troughs or hanging tributary forms. The Dießbachtal, the steep Gjaidgraben, the Schrainbachtal, the Schapbachtal, and the Kaunertal east of the southern end of the Königssee are further examples.

The surface of the plateau glacier reached a maximum height of 2300 m in the south (around the Großer Hundstod), declining to 2000 m around the Schneiber and the Gjaidkopf, and to 1500 to 1550 m, where the southern end of the Königssee lies nowadays. The further decline of the glacier surface towards the basin of Berchtesgaden in the North was minimal as is indicated by moraines in the Kührointalm area (in 1440 to 1370 m) and the Gruben-Alm and Mitterkaser-Diensthütte area (in 1390 to 1350 m).

This means that the groups of the Hochkalter and Watzmann towered high above the surface of the valley glaciers and were therefore subject to individual local glaciation. Slopes and valley bottoms below the glacier surface were coated with moraines to a large extent.

Large areas are covered by moraines from the Eckau-Alm and the Kitzkartauern as far north as the upper border of the map, and on the northern side of the Watzmann group. A number of stadial moraines can be found for example near the northern end of the Königssee and at the mouth of the Wimbachtal, the Blaueistal and the Eisgraben, and in many other places. So far, there have been no attempts at dating them exactly.

In most cases, the multiple glaciation resulted in a decisive modification of pre-glacial forms, or even their destruction. The fact that the dolomite plinth has been bared in some places by erosion of the Dachsteinkalk cover has led to an accelerated destruction of older forms there, as erosional processes on dolomites are of much more impetus.

An ideal example can be seen in the upper Wimbachtal with its sack-shaped widening and its markedly structured and brittle, crumbly walls.

4. Factors relevant to recent geomorphological processes

Dealing with the recent geomorphological development in the region of the "Königssee" map sheet, special attention must be paid to gravitational and corrosive processes because of the large number of walls and cliffs and the existence of soluble rock in large areas. Rockfall of all scales, rockslides, snow ploughing or scouring, avalanches and valley filling are examples of gravitational processes.

Rockfall and rocksliding is closely linked with the development of cliffs and is facilitated by repeated freezethaw activity. The Berchtesgaden meteorological station reports an average of 122 days with frost per annum; there are 184 days of frost, or freezing-thawing, at the Watzmannhaus (period 1947 - 1954), and the number increases with altitude. There is also a considerable amount of precipitation, and a great number of rainy days. Frequent wetting and freezing-thawing facilitate weathering, especially of fissured types of rock (e.g. "Ramsaudolomit" or Karnian-Norian dolomite); so it is obvious why walls and cliffs developed in the dolomites show such a delicately-masoned surface, and why there are such large talus cones at their feet, on which mudflows and fluvial processes may originate. During the course of the Holocene this has led to valley-filling, like in the Wimbachtal, the Klausbachtal, the Hochwies and the Hocheis.

Although they occur at much longer intervals, rockslides have considerably greater impact than rockfall has; it is above all the masses of debris deposited which give evidence of their effectiveness. They also can be traced back to the Late Glacial, and they occur in the form of rockslide moraines ("Sumperloch" in the Blaueis valley) or huge erratic boulders ("Feuersteine" - E 45 67 84, N 52 72 90, and near the northern end of the Königssee). A considerable influence on the shaping of the surface must be attributed to avalanches, as they sweep loosened material from walls and steep slopes bare of vegetation, and deposit it in the form of cones further down. The pressure exerted by a thick snow cover initiates the so-called "Rasenschälen" (snow-ploughing) or the forming of "Blaiken", i.e. shallow denudated patches bare of vegetation; those may be widened and deepened by further snow-scouring, or moulded into grooves and gullies running downhill. It is hardly feasible to express these forms in the map because of their small size, yet they may be found all over the area of the map - between the Wimbachschloß and the Hochalmscharte, on the eastern and western flank of the Wimbachgries, at the Alplboden, or on the southern side of the Kühleitenschneid.

Corrosive processes become prevailing in the southern section of the map, where characteristic forms like dolines, uvalas, or dry valleys show up. But the corrosion of the limestone and the shaping of those forms take place at an extremely slow pace. Judging form present-day climatic conditions, a mere 10 millimetres of rock can be assumed to be corroded off a level surface per millenium. This rate can be deduced from lapies that have developed on glacially smoothed rock surfaces or on boulders of datable rockslides, or expecially from "Karrenfußnäpfe" (pot-holes developed at the foot of solid limestone knobs) or "Karrendorne" (sharp pointed remnants of former lapies), and, most exactly, from karst tables (erratic boulders covering a stump of limestone left over from solution). Karst depressions of bigger dimensions, ranging from one meter to several hundred meters in diameter, like karst funnels or wells, "karst lanes", larger-type to giant dolines, uvalas, or dry karst valleys, are thus to be interpreted as elements of an older relief.

Amongst denudative processes, which also include gravitational denudation, it is especially the transport of material by "Muren" (mudflows) that has to be mentioned. "Muren", i.e. a mixture of debris, soil, water, and vegetation particles in motion, originate on masses of loose material after continuous heavy rainfall, or after torrential showers. It is plausible that the dolomite and "Gries" areas are particularly prone to that kind of denudative processes, This was examined more closely in the Wimbachtal (SCHLESINGER 1974). A total amount of up to 50 000 m^3 may be transported in a single event, occasionally burying and destroying whole areas of wood. As it is not always possible to make a clear distinction between "Muren" and fluvial processes, the separating line on the map between denudative and fluvial processes is not to be taken as something absolutely fixed in all cases.

Only relatively small patches with a prevailing of fluvial processes turn up on the map sheet. Besides the Wimbachtal, it is the Klausbachtal, where a former, bigger Hintersee has been confined to its present size by accumulated material building up the valley floor now, as well as the Eisgraben with the St. Bartholomä alluvial fan, the latter also formed in post-glacial times with a volume of an estimated 150 million m^3. Thus, an average accumulation rate of 30 000 to 40 000 m^3 per annum can be assumed for the woodless period of the Post-glacial. Fluvial processes have also led to the development of the Klingerbach and Krautkaserbach alluvial fans north of the Königssee. Nowadays, they are being dissected by these streams and by the Königssee Ache, the latter having developed a sequence of terraces.

Only a residuary total of 0,3 km^2 is characterized by glacial processes nowadays in the area covered by the map, whereas they dominated more than 5/6 of the area during the pleistocene glaciations. They only occur in the Blaueis area (Hochkalter group), on the Watzmann glacier, the "Eiskapelle", and on some larger firn patches such as the one in the "Hochfeld" northeast of the Hocheisspitze (E 4564, N 5268 - no name given on the map). Areas with clearly recognizable moraines (stadial or high-glacial) and morainic cover were also allotted to glacial processes which of course is not quite consistent as they are nowadays dominated by denudative processes. The same applies to forms which genetically have to be rated fluvio-glacial, like in the lowermost part of the Wimbachtal, in the Abwärtsgraben northwest of the Gotzentalalm (E 45 75 04 to 25, N 52 69 00 - no name given on the map), near the ruins of the Sagereckalm, or around the Grünsee.

Cryogenic and biogenic processes do not play any decisive role in the shaping of the area. The alpine zone and the structure of the substratum do not generally favour cryogenic processes; fine sands and pelites are lacking in sufficient quantities to develop frost patterns. Biogenic activities have led to the development of the 'Salletstock' raised bog at the southern end of the Königssee.

Anthropogeneous influences on the surface of the area are also of minor impact. It is to be considered, however, that human activities affect much larger areas indirectly than they do directly. Thus, some of the indirect consequences have been caused by the reduction of woodland for alpine pastures, for timber needed in the saltmines, and fuel for the saltworks of Berchtesgaden and Schellenberg. This meant a considerable thinning-out and disintegration of the formerly closed forest cover, or even the complete destruction, especially near the timberline, of whole areas of wood. One of the consequences of the reduction of woodland was intensified erosion and, amongst others, the uncovering of rock surfaces carrying rounded lapies; at the same time, areas lower down were affected by avalanches and "Muren". Events like that have been recorded of the Wimbachtal as well as the Hochwies. As for direct influences of human activities, it is mainly the regulation of rivers and torrents which is to avoid, or at least lower, damage in times of flooding. Thus, a series of steps and barriers have been inserted into the channel of the Krautkaser ravine (upper right corner of the map); the Klausbach (upper left) has been fixed between lateral dams, the Wimbachgries has been stabilized by the erection of groynes ("Archen"), and a new ditch as been constructed leading south-southeast from the mouth of the Eisgraben to the Königssee. Only in the village of Königssee is there any mentionable sealing of the ground by houses or roads.

Since the act of the establishment of the Berchtesgaden National Park has been passed (part of which covers nearly all the map sheet) there is no more serious danger for the area and its ecology being affected negatively by human activities. The area of the Berchtesgaden National Park is to remain untouched in its natural state; it must not be altered through any kind of economic activity.

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Geomorphological mapping at the scale 1 : 100 000 in the central uplands of the Federal Republic of Germany (GMK 100, Sheet 1, C 5510 Neuwied, as an example)

with 3 Figures and 1 Table

HERBERT LIEDTKE

A b s t r a c t: The geomorphological survey of sheet C 5510 Neuwied according to the instruction of mapping for maps of the scale 1 : 100 000, which was carried out with the help of the Deutsche Forschungsgemeinschaft (German Research Foundation) in the period from 1979 till 1983, has been finished successfully after some initial difficulties. The main problem of the mapping has been the selection of the process colour for the Central Uplands, which is interspersed with magmatic and volcanic products. In the end the characteristic and the more accidental main features of magmatic and volcanic forms were given priority to the subsequent denudation. Besides that the main interest was centered on the correct mapping of the relief and its development, whose nature, however, could not be represented in greater detail. Moreover, the reference to the complex of the Rhenish Shield was also taken into consideration. Numerous facts could be collected so that it was possible to get a conception of the geomorphological development in the Westerwald. According to that there was an old pre-Oligocene Tertiary planation surface with some still existing ridges. In the northern and western Westerwald the characteristic features of the present courses of the main rivers existed at the end of the Oligocene. These facts will be explained in more detail in the explanatory notes on the geomorphological map of Neuwied.

Geomorphologische Kartierung im Maßstab 1 : 100 000 in der zentralen Mittelgebirgsschwelle der Bundesrepublik Deutschland (am Beispiel GMK 100, Blatt 1, C 5510 Neuwied)

K u r z f a s s u n g: Die von 1979 - 1983 mit Hilfe der Deutschen Forschungsgemeinschaft durchgeführte geomorphologische Aufnahme der Topographischen Karte C 5510 Neuwied, gemäß der Kartieranleitung für Karten des Maßstabs 1 : 100 000, hat sich nach einigen schwierigen Anfängen letztlich zügig durchführen lassen. Hauptproblem der Kartierung war die Wahl der Prozeßfarbe für von magmatischen oder vulkanischen Gesteinen durchsetzte Mittelgebirge, wobei die charakteristischen und mehr zufälligen Großformen magmatischer und vulkanischer Bildungen Vorrang vor der späteren Abtragung erhalten haben. Daneben galt das Hauptaugenmerk der korrekten Aufnahme des Reliefs und dem allerdings im einzelnen nicht sichtbar darstellbaren Ablauf der Reliefentwicklung im Rheinischen Schiefergebirge. Hierzu konnten zahlreiche Fakten gesammelt werden, so daß sich eine Vorstellung über den geomorphologischen Entwicklungsgang im Westerwald gewinnen ließ. Danach bestand hier bereits vor dem Oligozän eine alttertiäre Flachlandschaft, aus der heute noch bestehende Höhenrücken herausblickten. Am Ende des Oligozäns waren im nördlichen und westlichen Westerwald bereits die Grundzüge des heutigen Gewässernetzes vorhanden. Einzelheiten hierzu sind in den Erläuterungen zur Geomorphologischen Karte Neuwied enthalten.

Cartographie géomorphologique en échelle 1 : 100 000 dans le massif rhénan central dans la République Fédérale d'Allemagne (par l'exemple de GMK 100, feuille 1, C 5510 Neuwied)

R é s u m é: L'établissement géomorphologique de la carte topographique C 5510 Neuwied selon les instructions cartographiques pour des cartes en echelle 1 : 100 000, fait 1979-1983 et supporté par la DFG, se fit exécuter assez vite après que quelques difficultés initiales avaient été surmontées. Le problème principal fut établi par la choix de la couleur des processus pour des montagnes moyennes constituées par des roches magmatiques et vulcaniques. Les grandes formes caracteristiques et plutôt accidentelles du façonnement magmatique et vulcanique ont reçu priorité avant l'ablation postérieur. En outre, on a fait une attention particulière à l'établissement correct du relief et au cours du developpement du relief en Rheinisches Schiefer-

gebirge, lequel ne peut pas être décrit en détail. A cela des nombreux faits pouvaient être assemblés de sorte qu'on ait gagné une conception sur le developpement géomorphologique en Westerwald. Déjà avant l'Oligocène, une paysage plaine tertiaire antérieure existait ici dominée par des sommets qui existent toujours. A la fin de l'Oligocène, les traits principals du réseaux hydrographique récent étaient déjà constitués en Westerwald septentrional et occidental. Les notices explicatives de la carte géomorphologique Neuwied contiennent des détails supplementaires.

Contents

1. General geomorphological mapping with area symbols at the scale 1 : 100 000 (GMK 100)

Within the scope of the Priority Program „Detailed Geomorphological Mapping" (GMK), supported by the German Research Foundation, the Topographic Map C 5510 Neuwied was also mapped. It is situated in the centre of the Rhenish Shield, reflecting the characteristic types of the relief in the geological basement. These relief forms are widely distributed in different parts of the German Central Uplands. This primarily refers to the widespread, often extremely flat planation surfaces, but also to smooth ascents, to mountaineous areas or interior basins. In addition we find volcanic features, which have interspersed the Central Uplands in points or larger covers since the Middle Tertiary and valleys, which often do not show any relation to the tectonical structure. While researchers eagerly inquired into residuals of equal-levelled planation surfaces until the Middle of this century, now the view is generally accepted that the big rectangular block of the Rhenish Shield did not move as steadily during the Tertiary and Quaternary as it has been thought so far; on the contrary the suspicion is obvious that it underwent very differentiated uplift and subsidence in its individual parts. Of course, the altitude of the marine Upper Cretaceous on the High Venn south of Aachen has always demonstrated those differentiated movements, but people have been reluctant for a long time to draw the necessary conclusions and to give up the accustomed picture of a steady and uniform en-bloc-uplift and the simultaneous formation of a steplike series of planation surfaces. But which easily acceptable idea of development should be advanced against the theory of a series of planation surfaces?

The considerations concerning the development of planation surfaces were based on their general or detailed mapping. Also a modern geomorphological mapping according to the legend of the GMK 100 (FRÄNZLE et al. 1979) records all perceptible surfaces and surface steps, but at the same time all the other geomorphological characteristics of the relief are surveyed and used for the characterisation, the interpretation of the development of relief forms. The detailed geomorphographic representation of forms results from their characterisation, definition and their association with the list of symbols. Now and then it is necessary to mark distinctive form characteristics and to integrate additional symbols into the legend. But one has to ask, if all relief forms can be shown, because the space of the map, especially with a scale of 1 : 100 000, requires a strong generalization. The accurate reproduction concerning singular geomorphological features, which are smaller than 8 ha (8 mm^2), must be either obliterated or indicated by means of a symbol.

Apart from the geomorphological forms also the processes are presented, which are decisive for the relief form. To this end 15 area coulours representing different processes with 2 additional colour gradations are available for further differentiations. In spite of the multitude of process colours problems often appear as for the determination of the correct process colour. So, the question arises, whether in the Central Uplands, Tertiary sheet-washing fluvial processes (green), denudative processes (ochre), which have been active for long periods, relief reducing processes (dark-yellow) as a result of loess accumulation, dissection by fluvial valleys (green) or in consequence of periglacial modification smoothing processes (heather) must be stressed. Must a basalt cone on a planation surface be coloured *volcanic* (ruby), *periglacial* (heather) or *denudative* (ochre)? The accumulation terraces of the Rhein-Main-plain, for example, are formed by fluvioperiglacial deposits, in the formation of the terraces of the River Mosel and the River Rhine fluvioglacial melt-water-streams were participating, and the redeposition in the recent flood plains clearly originates from Holocene fluvial processes. Therefore, the selection of the correct process colour is quite difficult; it is suggested, to use a checklist, from which priorities of processes are obvious and by which a certain similarity in colour of adjacent map sheets is guaranteed. This priority list has resulted from practical experience and has only a few fixed regulations concernig the application of certain process colours; for example all processes basing on fluvial dynamics, are presented in fluvial green. For the large fluvioglacial accumulation terraces icy green is used, and for the periglacial dry valleys and the small reworked residuals of terraces the colour of heather is employed. Apart from these few special regulations, the checklist is of good use for the right selection of the other process colours. In the map sheets of the Central Uplands the course of valleys, periglacial accumulations, volcanic structures or denudational relieff forms including the planation surfaces are clearly accentuated. Therefore maps of the Central Uplands principally show denudative process colour (ochre), in which ruby-coloured volcanic structures can appear as area symbols or in points. This is the case on sheet *Neuwied* due to the Tertiary basalt and phonolith eruptions and the Upper Quaternary pumice deposits near the River Rhine and in the Neuwied basin. In detail, the checklist can be individually refined according to the special requirements of each geomorphological map, as the experience of sheet *Neuwied* has shown (REINIRKENS 1982). Among the predominantly important geomorphogenetic process colours a striking light red is used, in order to demonstrate present-day relief forming processes.

Information which is important for all geoecological problems consists of details concerning the subsurface material, which, as a rule, cannot be taken from either the geologic or the soil map. Thus the occurrence of loess, for instance, is most relevant for all agricultural, hydrologic or forest interests. Of course, the distribution of pure loess is registered in geologic maps (as far as they are available). Information about loess admixtures, however, are missing. But especially these parts are geoecologically effective in the subsurface material. In the same way it is possible to show, for instance, the particle size distribution of a slope debris or an accumulation terrace by means of the subsurface material symbols. So reference to geomorphology is additionally given by information concerning the material. In the map sheets of the Central Uplands the scale, however, sets certain limits to the possibility of the presentation.

Geomorphometric characterization of forms, geomorphogenetic indications of processes, and symbols for the subsurface material which are useful for geoecological interpretations show strong connections to other earth sciences and contain together with geologic and soil maps the basic information for the understanding of our environment. In addition, geomorphological mapping with area symbols affords a general view of a certain area and enables to recognize problems more easily; the presented multifarious statement of geomorphological forms and the deducible relations between form and process improve the geomorphogenetic possibility of interpretation and stimulate the emergence of new ideas for the relief formation of an area.

2. Subdued mountain forms as a part of the Central European relief

Anyone speaking of the Central Uplands first of all imagines the smooth surface forms in the Paleozoic basement of the Rhenish Shield, the Harz, the Black Forest, the Franconian Forest, the Oberpfälzer Forest or the Bavarian Forest. While the three last-named form the western border of the old Moldanubic basement, both the Black Forest and the Harz are isolated uplifts. In comparison with it the Rhenish Shield forms a huge compact block of about 25 080 km^2. In spite of their separate positions and their differing kind of uplifts, in spite of differing altitudes and more or less intensive intersections of magmatic rocks, these mountains have several features in common, especially the extensive subdued planation surfaces and, of course, all those problems, which are connected with the discussion of the origin of these planation surfaces. So, again and again the question arises, whether the surfaces perhaps might be residuals of a pre-Triassic planation surface, or whether they might not have been originated before the Upper Cretaceous, the Old or Upper Tertiary. Also the relations to the foreland of the basement are not always clear, and the tectonic movements did not have the same consequences in all areas. This becomes

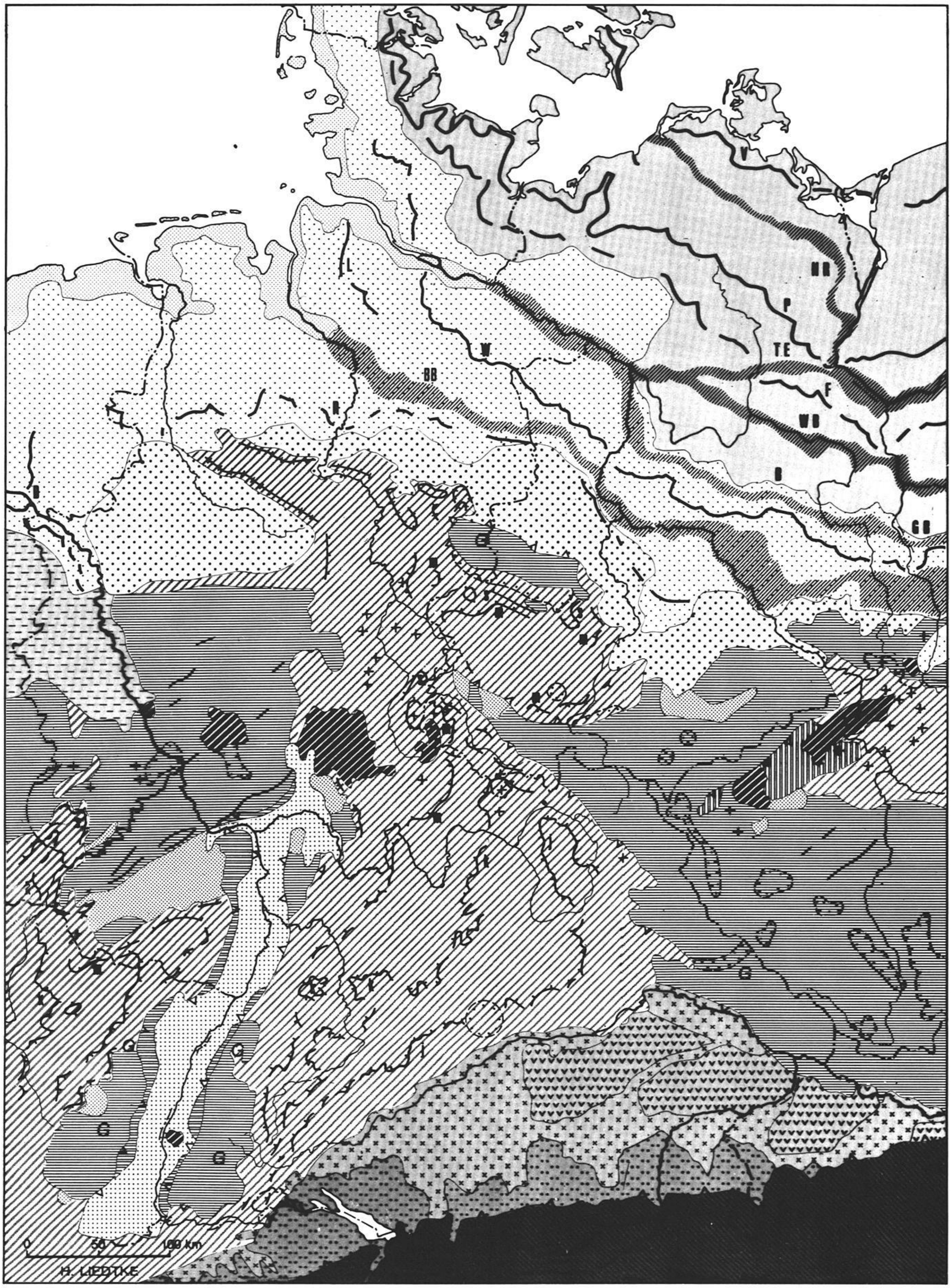


Fig. 1: Areas of Similar Surface Forms in Western Central Europe.

Islands, marshes and tidal flats of the North Sea coast

Young moraine landscape with terminal moraines and spillways (Urstromtal), with lakes and closed depressions, including the coast line of the Baltic Sea with sea-cliffs and sand spits

Old moraine landscape with subdued terminal moraines and spillways (Urstromtal), generally without lakes

Old moraine landscape, generally without lakes, partly covered by loess, sometimes with driftless outcrops of Mesozoic rocks

Gently undulated relief on unconsolidated or indurated Tertiary or Quaternary sediments, partly covered by loess

Central Uplands with steplike peneplains of different heights and superimposed hilly mountains on strongly folded Paleozoic sediments or magmatic rocks ("Rumpfschollengebirge"), partly formed by mainly Tertiary Volcanism

Peneplains or hillocky uplands on Permian sediments or magma and lava residuals

Lowland of the Upper Rhine Valley on unconsolidated Quaternary sediments with marginal plateaus or step faults

Undulated or flat relief of the Eger graben

Hogbacks, cuestas and tablelands mostly of Mesozoic sandstones and limestones, in the northern part with small local updomings or basins, in the Swiss Jura strongly folded

Gently undulated relief of the Alpine Forelands on Quaternary or Tertiary sediments partly covered by loess

Old moraine landscapes, fluvioglacial gravels and flood plains of the Alpine Forelands.

Young moraine landscape with numerous lakes and closed depressions of the Alpine Forelands with outcrops of Mesozoic rocks near the Alps

High Mountains relief forms

Larger areas of Tertiary lava sheets or groups of isolated lava knobs

Larger basins caused by tectonics, removal, salt solution in the underground or meteorites

Fault line

Cuesta (of s Bunter, k Keuper, and j Jurassic)

Hogback

Saalean Terminal Moraines: D Drenthe Stage, R Rehburg Stage, L Lamstedt Readvance, W Warthe Stage

Weichselean Terminal Moraines: B Brandenburg Stage, F Frankfurt Stage, P Pomeranian Stage, V Velgast Phase

Urstromtal (glacial spillway): BB Breslau-Bremen Urstromtal, GB Glogau-Baruth Urstromtal, WB Warsaw-Berlin Urstromtal, TE Thorn-Eberswalde Urstromtal, NR Netze-Randow Urstromtal

G Proved local glaciation of the Central Uplands clearly apparent in the Rhenish Shield, where areas exist with more or less strong uplifts, which can be situated next to the downthrown fault blocks. Just in sheet *Neuwied* it can be demonstrated that the Rhenish Shield has nowise moved in a uniform way; on the contrary undulations and faults have a decisive bearing on the present superficial configuration.

Although especially the tectonic conditions in other Paleozoic rocks often differ considerably from those of the Rhenish Shield - because the latter are mostly much smaller, or they are lopsided (Harz, Erz-Mountains), or because they are only forming a narrow spur (Thuringian Forest) - it is quite clear that they yet contain the very same surface parts and similar stepped planation surfaces as they exist in the Hunsrück or in the Eifel. Also here the question arises, whether there was a post-Hercynean cover of late-Permian or Mesozoic sediments, whether the present surface residuals are bound to a Permian planation surface or whether the striking sections have tectonical or climatic geomorphological reasons. Doubtlessly it is not the business of the geomorphological mapping to solve all unsettled problems, but the results are conducive to the answer of the one or the other question. Nevertheless, the landscapes of the pre-Permian rocks occupy about 16 % of the surface of the Federal Republic of Germany and form an independent striking form group, breaking up Central Europe into similar surface forms (Fig. 1).

3. Results of recent geological and climatic geomorphological research in the Rhenish Shield

Within the Priority Program of the German Research Foundation *Vertical movements and their causes with examples of the Rhenish Shield*, which was carried out in the years from 1976 until 1982, several new results were obtained, which are of general importance also for geomorphology. Many places with in some cases even datable sediments of Tertiary age have been found, which enable to get a new idea of the distribution of land and sea in the Lower Tertiary. Detailed investigations made the differentiated tectonics in the Rhenish Shield more understandable. About many places in Central Europe new information concerning the climate conditions in Tertiary got known, which show striking variations in temperature in spite of the so far accepted gradual temperature drop.

The Rhenish Shield was first completely free from transgressions after its folding during the Carboniferous. Only the Lower Permian grazed the southern border, and during the Upper Permian the sea advanced some kilometres to the northern east border. During the Bunter a bisection of the Rhenish Shield took finally place by the subsidence of the Eifel trough, but after that the Rhenish Shield rose above its environs and was subject to denudation. Only in the beginning of the Middle Jurassic the picture changed decisively (MURAWSKI et al. 1983), when the former north-south structures (Eifel trough and Hessen trough) lost their significance, and when ocean margins - especially during the Upper Cretaceous - transgraded on the Rhenish Shield from north to south. In Tertiary the coast lines reshifted against the centre of the old mountains. Most probably a connection between the Upper Rhine Valley near Bingen and the Lower Rhine embayment near Bonn came into existance in the Upper Oligocene, following the Middle Oligocene (Rupel) transgression which covered the lower parts of the Eifel and Hunsrück because of an uprising sea level, in the course of which an alluvial plain nearby the coast developed in the area of Neuwied (MEYER et al. 1983, GLATTHAAR & LIEDTKE 1984). This sea ingraded into the eastern Hunsrück from north and south, forming an irregular coast line according to the dissected relief (ZÖLLER 1983).

4. The characteristic features of the relief on sheet C 5510 Neuwied and the reconstruction of the development of the landforms

Sheet *Neuwied* is located in the centre of the Rhenish Shield and participates consequently in almost all types of relief occuring in mountains with Paleozoic rocks. Proportionally the denudative and periglacial shaped plateaus are most common; they are characterized by some smaller monadnocks and a soft or sometimes sharp and deep dissection by valleys. Vast valleys with wide flood plains and clearly traceable residuals of terraces, which divide single parts of the Rhenish Shield, are presented by River Rhine and River Sieg. An Oligocene-Miocene cover of basaltic-phonolithic magma or ashes lies on the eastern part of the plateau, and over the sheet dispersed several single standing, partly also Pliocene basalt- or phonolith knobs exist. In the southwest of the sheet the tectonic becomes perceptible with the subsidence of the Neuwied basin, because two crossing dislocation systems (Andernach fault, Sayn fault) cause a distinct lowering of the elevation (BIBUS 1983). During the glacial period the Neuwied basin had been covered by loess, while the plateaus had been provided with loess admixtures. At last an only 10 000 years old volcanism blessed the Neuwied basin with a few meters and the marginal parts of the western Westerwald with a few decimeters of pumice layer. Apart from the rare glacial forms in the higher parts of some Central Uplands and from Karst features all typical geomorphological processes in mountains with a Paleozoic basement are thus represented in sheet *Neuwied*.

Sheet *Neuwied* belongs with 90 % to the Westerwald, which is situated between River Sieg and River Lahn. The Neuwied basin as the lowest part of the Middle Rhine basin represents 6 %, the Sieg valley and the northward adjacent Süderbergland occupy 4 %.

Except for the Neuwied basin the Westerwald between Neuwied and Siegen contains only Devonian beds which are covered in the northeast of Koblenz by Tertiary clay, basalt and basalt tuff. The Devonian is represented by the Lower Devonian Siegen beds and Ems beds just as the Middle Devonian Eifel series in the southeast. Slates are dominating in all layers, which are partly interspersed with sandstone layers. In the intermediate Siegen beds quarzites and quartose greywackes were formed out. A strict connection of the geomorphological main features with certain Devonian subdivisions is, however, not perceptible, because the mayor elevations in Devonian rocks are located in completely different stratigraphic positions (Tab. 1).

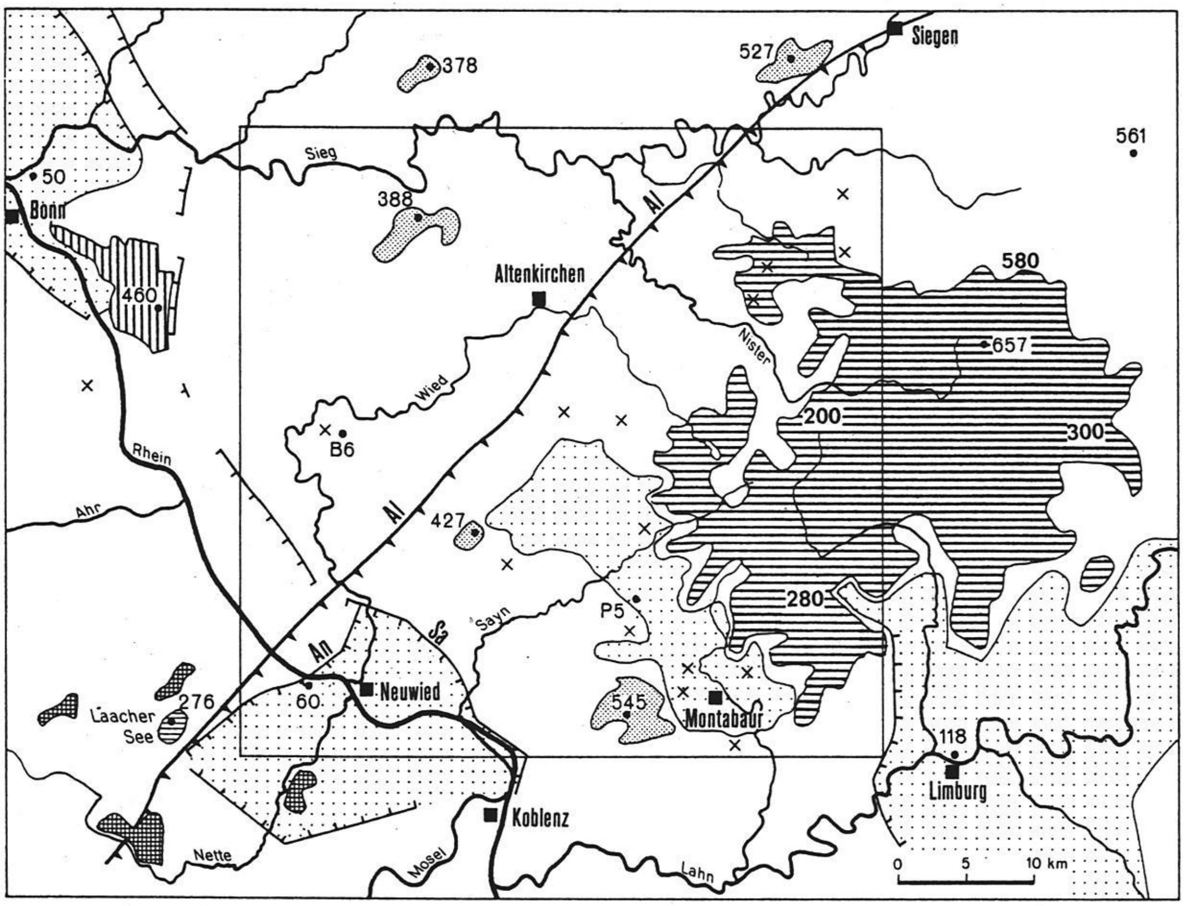
On this Devonian basement with its hercynian structures gently rolling landforms developed (primary flat level), which have only been topped by some higher elevations. These elevations are clearly overlooking their vicinity still today: to the north of River Sieg the Nutscheid (378 m), in sheet *Neuwied* to the south of River Sieg the Leuscheid (388 m), between River Wied and River Sayn the Dernbacher Kopf (427 m) and between Montabaur and Koblenz the Montabaurer Höhe (545 m). In the Upper Eocene, in the Lower and Middle Oligocene a sedimentation of clays and sandy-gravelly sediments took place, which are widely covered on their part by basalt of the Upper Oligocene and the Lower Miocene. In the eastern part of sheet *Neuwied* this volcanism produced a superimposed younger level, which forms the High Westerwald and which comes up to 567 m in the Fuchskaute (outside of sheet Neuwied). As the third element the basins to the south of sheet *Neuwied* are to mention (Fig. 2), which were formed either by tectonics (Neuwied basin) or by fluvial erosion (combined with tectonics?) (Montabaur basin).

The oldest geomorphologic element of the relief can be reconstructed from an intensive white weathering mantle of totally bleached Devonian slates, sandstones or greywackes (Weißverwitterung). The weathering mantle is still indicative where it could be preserved under a cover of Upper Eocene clays or other deposits. Because of the fact that Weißverwitterung does not show relevant differences in elevation the landform must have been nearly plain during its formation.

Tab. 1: Stratigraphy of the Devonian on Sheet "Neuwied".
(Source: Deutscher Planungsatlas - Vol. Nordrhein-Westfalen: Geologie. – 1 : 500 000, 1976).

Period	Epoch	Material
Middle Devonian	Eifel	slate, sandstone
	Upper Ems	slate, sandstone, keratophyre, Ems-quarzite; point 545 in fig. 2
	Lower Ems	slate, sandstone; point 388
Lower Devonian	Upper Siegen (Herdorf)	sandy slate with sandstone beds: point 378
	Middle Siegen	phacoidal slate with sandstone beds (upper greywacke series)
	Lower Siegen	slate with sandstone beds (Lower greywacke series)

The clayey-silty facies of Hunsrück slates was sedimented during the Siegen and the Lower Ems epoch (e.g. point 427 m in fig. 2).



(dotted)	Geomorphological and (or) geological basin	P5	Basalt eruption Piuslinde in the Montabaur basin 5,6 m.y. ago
(horizontal lines)	Area of the uninterrupted cover of basalt or basalt tuffs, 30 - 17 m.y. ago (Hoher Westerwald)	527	Giebelwald
		378	Nutscheid
(vertical lines)	Area of volcanic rocks and tuffs, 28 - 15 m.y. ago (Siebengebirge)	388	Leuscheid
		427	Dernbacher Kopf
(cross-hatched)	Quaternary eruptions (Eastern Eifel)	545	Montabaurer Höhe
┬┬ ┬	Fault	Al	Altenkirchen fault
• 50	Elevation in m	An	Andernach fault
580	Elevation of the basalt base	Sa	Sayn fault
B6	Basalt eruptions of the Bertenauer knob near Neustadt/Wied at about 6,2 m.y. ago	×	Evidence of deeply weathered Devonian (Weißverwitterung) or its base (Wurzelzone)

Fig. 2: Main relief features on Sheet C 5510 Neuwied.

Also the covering clays are an indication of a widely subdued relief and a surface, being interspaced by soft basins. Although the processes that led to this Weißverwitterung, are not clear down to the smallest detail, a long period of decay processes must at least have taken place in order to produce a several meter thick Weißverwitterung. The question is, whether the Weißverwitterung (grey loam) is only the result of hydrothermal decay, because its occurrence also by local beds was proved, and the drained off residual minerals, such as iron or manganese, have often been accumulated in marginal zones. Moreover, hydrothermal decay is also imaginable as a result of Tertiary volcanism (MEYER et al. 1983). Where the Weißverwitterung is not preserved any longer, because the protecting covers have been graded by decay, often the lower part of this Weißverwitterung can be found, which is often visible in cuts as a friable decaying root zone of Devonian rocks.

In the Lutetian (Middle Eocene) the western part of Central Europe lay in a climatic belt, which had a mean annual temperature of 22 - 25° C and consequently enabled tropical vegetation. Within the following Lud (Upper Eocene) the temperature, however, decreases quickly to 15° C. Now, after weak tectonik movement, eroded Weißverwitterung was settled in fault troughs as clay. The relief itself did not change basically, even though the fluvial system of the Vallendar gravels was forthcoming in a west-east running Bitburg-Kassel syncline and transported sandy-gravelly material.

Also in the following Lower and Middle Oligocene (Lattorf and Rupelian) no decisive geomorphological changes happened, although an additional drop of temperature took place, which caused for a short time temperatures similar to those of modern Central Europe. From the west a transgression towards the South Eifel advanced, which brought the Rupelian sea up to the Wittlich basin (MEYER et al. 1983) and permitted the proof of a brackish fauna (KADOLSKI 1975). This transgression caused the disappearance of the Vallendar gravels, running previously from the Wittlich basin within the old Bitburg-Kassel syncline to the Neuwied basin. By the investigations of ZÖLLER (1983) a richly embayed transgression course of a brackish sea could also be reconstructed for the eastern Hunsrück, after there is no doubt about an assignment to the Rupel of so far fluvially interpreted Tertiary sediments of the Hunsrück (SONNE 1958). In 1973 BIRKENHAUER had already hinted at a deep ingression from the south into the western Hunsrück, at which a terrain of possibly high relief intensity disappeared under the sea (RATHJENS 1977). Of course, the question arises here, whether at that time a pre-form of the present Upper Middle Rhine Valley had already existed, in which, however, all deposits of Oligocene age were later destroyed by the large Rhine stream.

When the Rupel sea withdrew from the Rhenish Shield, the terrain of the western Westerwald lay only a few meters above the sea level. Within the Chatt (Upper Oligocene) an accumulation of the 10 - 20 m thick Arenberg series took place, under which the last residuals of a soft relief completely disappeared. A vast alluvial plain nearby the coast could come into being, from wich a few altidudes towered above the area (Montabaurer Höhe, Dernbacher Kopf, Leuscheid, Nutscheid). At the same time, however, two important events happened, which changed the relief decisively:

(1) With the retreat of the Rupel sea, 28 million years ago, basalt eruptions started in the High Westerwald, which alsmost lasted with their last eruptions till the end of the Lower Miocene, 17 million years ago (LIPPOLT 1983). At the same time the Siebengebirge came into being.
(2) Tectonic movements orientated in the (Middle) Rhine direction began and caused the still active subsidence of Lower Rhine embayment. It also caused the precondition of a new catchment system, by which the Upper Rhine Graben was connected later on with the Bay of Cologne, making possible the present course of the Middle Rhine.

With the end of the Oligocene, 24 million years ago, the main features of the relief development existed: A Rhenish trough crossed the Rhenish Shield on a large sandy-gravelly alluvial plain. In the Western Westerwald the present valleys were formed, and in the High Westerwald a basalt section towered up as high as 200 m and rose far visibly above its environs.

Little is known about the Miocene, because the Rhenish Shield was a denudation area. It is true that the valleys softly deepened as a result of a slight uplift, and that they tended towards a prime Rhine, which crossed the Rhenish Shield for the first time, 15 million years ago (BOENIGK 1982). During the Pliocene, the Pontian (Lower Pliocene) flat levels were formed, which passed the primary flat level as wide, only softly incised valleys. Their age can be proved by the basalt knob of the Bertenauer Kopf near Neustadt/Wied which was formed 6.2 ± 0.8 million years ago (LIPPOLT 1976) covering Wied sediments (GLATTHAAR 1976). During the Quaternary a new uplift took place and caused the deep incision of the present valleys. Only the Neuwied basin was an exception, which did not participate with the whole Middle Rhine basin in the uplift of the surrounding areas (BRUNNACKER & BOENIGK 1983).

5. Conclusions

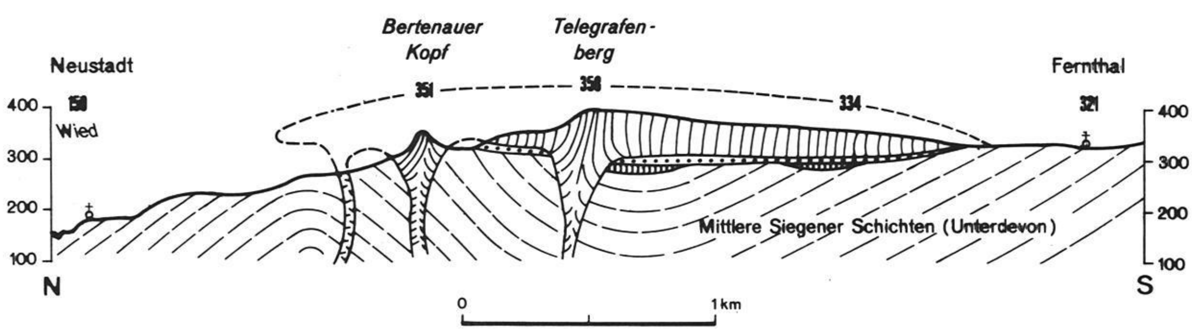
It turned out to be very advantageous that sheet *Neuwied* is located in the centre of the Rhenish Shield and that it is at the same time a central point of the Priority Program of the German Research Foundation *Rhenish Shield*; therefore, the geological, geomorphological, geotectonical and geophysical results were an advantage for the investigations in the Westerwald and in the Neuwied basin. The still existing residuals of Weißverwitterung under the Upper Eocene and Oligocene clays or the Oligocene-Miocene basalts just as the widespread root zones of this Weißverwitterung are helpful. But in the Rhenish Shield their distribution is no more paleogeographically conclusive; it is missing on monadnocks, and in some places the Lower Oligocene Vallendar gravels or the Münstermaifeld marls lie on the outcropped undecayed Devon. It remains uncertain, at what time the Weißverwitterung must be set. The last paleoclimatic possibilities existed in the Lower and Middle Eocene, but a much older (Cretaceous) origin cannot be excluded. As Weißverwitterung does not exist in the South German cuesta landscape, the conclusion could be drawn that it had developed already before the inclination of the South German Shield on the Paleozoic planation surface during the Lower Cretaceous and that it was preserved in a low position above the sea level into the Eocene, possibly with intermediate development.

QUITZOW (1982) pointed to the high age of the Paleozoic planation surface; he regards the 600 m level of the Eifel (R2) as a part of a subdued primary relief, which sloped northwards from the Vosges Mountains into the northern ocean, being slightly folded already in the Lower Tertiary. In the synclines the lower planation surface R1 came into being in 500 m today, in which the present water system has already been formed; this developed on broadly formed sheet wash plains. Inside this 500 m level the *Trogflächen* (trough levels), which lie in 400 m today, have already been incised in pre-Oligocene periods (LIEDTKE 1969). The Oligocene age of the primary relief of the western Westerwald, stated by HAUBRICH (1970), must therefore be given up.

According to QUITZOW (1982) the areal denudation till today is rather small; as a result of investigations of datable Eifel volcanoes it only amounts 2 m in 1 million years. These data are confirmed on sheet *Neuwied*, where the basalt of the Bertenauer Kopf (351 m) to the south of Neustadt/Wied lies upon Pliocene Kieseloolith gravels in 300 m (BURGER 1982). While northward a deep dissection by River Wied (150 m) took place, the terrain slowly rises southward and proves the small denudation rate during the last 6 million years. Already AHRENS & BURRE (1932) hinted at the surrounding plateau, which is situated between 300 and 320 m showing flat surface forms in general. The fact is remarkable that 6 million years ago a cover of gravels with a thickness of 4 m was accumulated on still existing residuals of Weißverwitterung in a situation, which belongs to the Upper Tertiary valleys, where a Weißverwitterung had not been expected (Fig. 3).

In 1977 RATHJENS pointed to the resistant monadnocks in the Hunsrück, towering the surroundings with 200 - 300 m (Idarwald 816 m, Errwald 695 m, Osburger Hochwald 708 m) so that higher mountainous parts in the midst of planation surfaces are obvious. Such as monadnocks tower highly above the surface niveaus in areas of recent sheet wash areas, also our relief presented those features in its earlier phases of development. In sheet *Neuwied* the Montabaurer Höhe, Dernbacher Kopf, Leuscheid and Nutscheid belong to such ancient heights.

It appears that the former opinions of completely homogeneous tectonical processes in the Rhenish Shield cannot be sustained any longer. Even in smaller areas the tectonic displacement is very differenciated, as the example of the Neuwied basin shows. In which degree the Montabaur (Herschbach) basin



basalt (nephelin-basanite)

Pliocene Kieseloolith-formation (after BURGER 1982), formerly considered to belong to the Vallendar gravels

deep chemical weathering and Eocene clays

Fig. 3: Cross section through the basalt knob Bertenauer Kopf after AHRENS & BURRE 1932 and KLÜPFEL 1935.

is only the result of young tectonics or had already been set up earlier and was eroded later on, is very difficult to determine for lack of conclusive and datable faults. In any case the arguments provided by AHRENS (1957) are not solid enough, in order to exclude a removal of material out of the basin. Apart from special cases (Neuwied basin, Limburg basin), we can generally stick to the assumption that until the end of Oligocene more local tectonical displacements and extensive undulations took place in the Rhenish Shield than in younger periods. The Upper Tertiary, however, produced more uniform movements, and during the Quaternary more or less regular movements had possibly taken place. To this refers the new investigation of the Pleistocene Rhine terraces by SEMMEL (1983), who proved north of Bingen that the Rhenish Main Terraces near Trechtingshausen were not locally dislocated as it has always been stated in literature till now. Also the altitude of the Kieseloolith series at heights of 300 - 320 m is constant to a large extent, as BIBUS (1983) ascertained in the surroundings of the Neuwied basin.

The question asked at the beginning, what kind of picture concerning the development of planation surfaces must be drawn today, is still open; only one result is certain: the climatic geomorphological impact on tectonic influences is a very slow process, which had considerably been overestimated by the late master BÜDEL. Consequently tectonic concepts gain a new higher probability for the interpretation of down-stepping planation surfaces.

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Assessment of soil parameters for predicting the potential impact of environmental chemicals by means of geo-scientific maps

with 5 figures and 3 tables

OTTO FRÄNZLE

A b s t r a c t: In industrialized countries environmental protection and planning are tasks of major importance comparable to the social problems of the 19th century. Basically their solution involves the determination of the stress tolerance of human populations and biocenoses, which requires comprehensive evaluation strategies.

By means of comparative laboratory and open-air experiments the essential operators or regulators controlling the soil passage of environmental chemicals are defined in terms of both pedochemical and physical soil characteristics and numerical regressions of the relevant sorption processes as revealed by representative experiments.

The last part of the paper deals with the exemplary evaluation of geo-scientific maps with the end to provide for supplementary areal data. Digitalisation procedures yield binary data which are subsequently grouped by means of entropy-analytical methods into classes of equal susceptibility to anionic reference chemicals whose reactions are known from the above experiments.

Die Erfassung von Bodenparametern zur Vorhersage der potentiellen Schadwirkung von Umweltchemikalien mit Hilfe geowissenschaftlicher Karten

K u r z f a s s u n g: In Industrieländern sind Umweltschutz und Umweltplanung zu Aufgaben ähnlicher Größenordnung geworden wie die soziale Frage im 19. Jahrhundert. Ihre Anforderungen werden wesentlich dadurch bestimmt, inwieweit die Grenzen der Belastbarkeit von Bevölkerung, Tier- und Pflanzenwelt erreicht oder überschritten sind. Dazu bedarf es umfangreicher Forschungen, und die vorliegende Untersuchung gehört forschungslogisch in diesen Bereich interdisziplinärer Umwelterfassung.

Auf der Grundlage vergleichender Labor- und Freilandversuche mit als Referenzsubstanzen ausgewählten Umweltchemikalien werden die für die Bodenpassage wesentlichen Ökosystemparameter angegeben. Dabei zeigt sich, daß die Komplexität des Wirkungsgefüges bislang häufig unterschätzt wurde. Um zu der notwendigen stärkeren Differenzierung zu gelangen, werden daher in einer theoretischen Einführung zunächst die Interdependenzen innerhalb des Bodenkörpers systemar erfaßt und anhand der experimentellen Befunde Korrelationsmöglichkeiten mit Chemikalieneigenschaften aufgezeigt. In welchem Umfang erforderliche Daten durch die Auswertung geowissenschaftlichen Kartenmaterials gewonnen werden können, ist der Gegenstand der abschließenden exemplarischen Untersuchung. Auf der Grundlage der experimentellen Befunde werden mit Hilfe einer speziell entwickelten Datenerhebungstechnik und der Entropieanalyse geopedologische Raumeinheiten gleicher Belastbarkeit in bezug auf eine anionische Referenzchemikalie bestimmt.

La détermination de parametres pédologiques en vue d'une prévision de l'influence négative potentielle de substances chimiques sur l'environnement à l'aide de cartes thématiques

R é s u m é: La protection et la gestion de l'environnement ont pris dans les pays industrialisés une importance comparable à celle des problèmes sociaux au XIX^{e} siècle. Leurs impératifs sont dictés principalement par les limites, et éventuellement le dépassement, des contraintes pouvant être assumées par la population, la faune et la flore. Des recherches approfondies ce domaine sont indispensables et la présente étude se place dans la ligne d'une analyse pluridisciplinaire des problèmes de l'environnement.

Les principaux paramètres de l'écosystème concernant les phénomènes de passage dans le sol sont exprimés en relation avec des produits choisis comme substance de référence et testés sur la base d'expériences comparatives en laboratoire et sur le terrain. Une première constatation est que la complexité des relations des différents facteurs a été jusqu'à présent souvent sous-estimée. C'est pourquoi, en vue d'une différenciation plus poussée nécessaire, les relations d'interdépendance systémique

entre les facteurs pédologiques seront d'abord présentés au cours d'une introduction théorique. Dans un deuxième temps des possibilités de corrélation avec les propriétés chimiques des substances seront établiés au moyen de résultats expérimentaux. Le dernier volet de cette étude se propose de montrer par un exemple dans quelle mesure les données nécessaires peuvent être obtenues à l'aide de cartes géographiques. Des unités spatiales géopédologiques ont été définies expérimentalement à l'aide d'un procédé spécial de collecte des données et d'une analyse entropique.

Contents

Since 1960, the chemical industry has grown at about twice the rate of the overall industry sector, and it plays a critical role in economic growth and industrial development throughout the world. In 1978, the chemical industry of OECD member countries manufactured products worth over 350 billion dollars, an estimated two-thirds of world production. It ensures the livelihood of many more people in those „downstream" industries whose very existence depends on the products the highly diversified chemical industry manufactures.

Just because these products are now an essential part of both economic and social life, governments and industry alike have become increasingly concerned about potential unintended consequences which the use of man-made chemicals could have on both human health and the environment. The numbers are striking: of some 4 million known chemical substances, some 60 000 are produced in commercial quantities, and it is estimated that as many as 1000 new substances reach the market every year (LEMERLE 1981). Consequently a number of key chemical-producing countries have passed, or are enacting, general substance control legislation. Common to all these legal instruments is the preventive aspect, i.e. the notification of chemicals prior to marketing which entails the presentation of data derived from laboratory investigations together with additional information permitting the evaluation of potential hazards.

Such a comprehensive assessment of the potential ecotoxicity of new chemicals implies the determination of their persistence and distribution potential on the one hand, and the analysis of the respective modes of immission and the structure of ecosystems on the other (FRÄNZLE 1983 a). Since two of the most essential regulatory compartments of any such system, i.e. its biocenoses and soils, are both directly related to or decisively influenced by geomorphology, it is the aim of the present paper to give an example of the interpretation of geomorphological and related informations with respect to assessing relevant soil parameters for the prediction of the distribution of chemicals released into ecosystems. It is based on the results of comprehensive experiments in the laboratory and on experimental plots (FRÄNZLE 1982 a), in particular those of shaking experiments which yielded the majority of data used for comprehensive regression analytical evaluations and modelling purposes by means of sets of simultaneous differential equations

1. Soil moisture balance and fluxes of potentially toxic substances

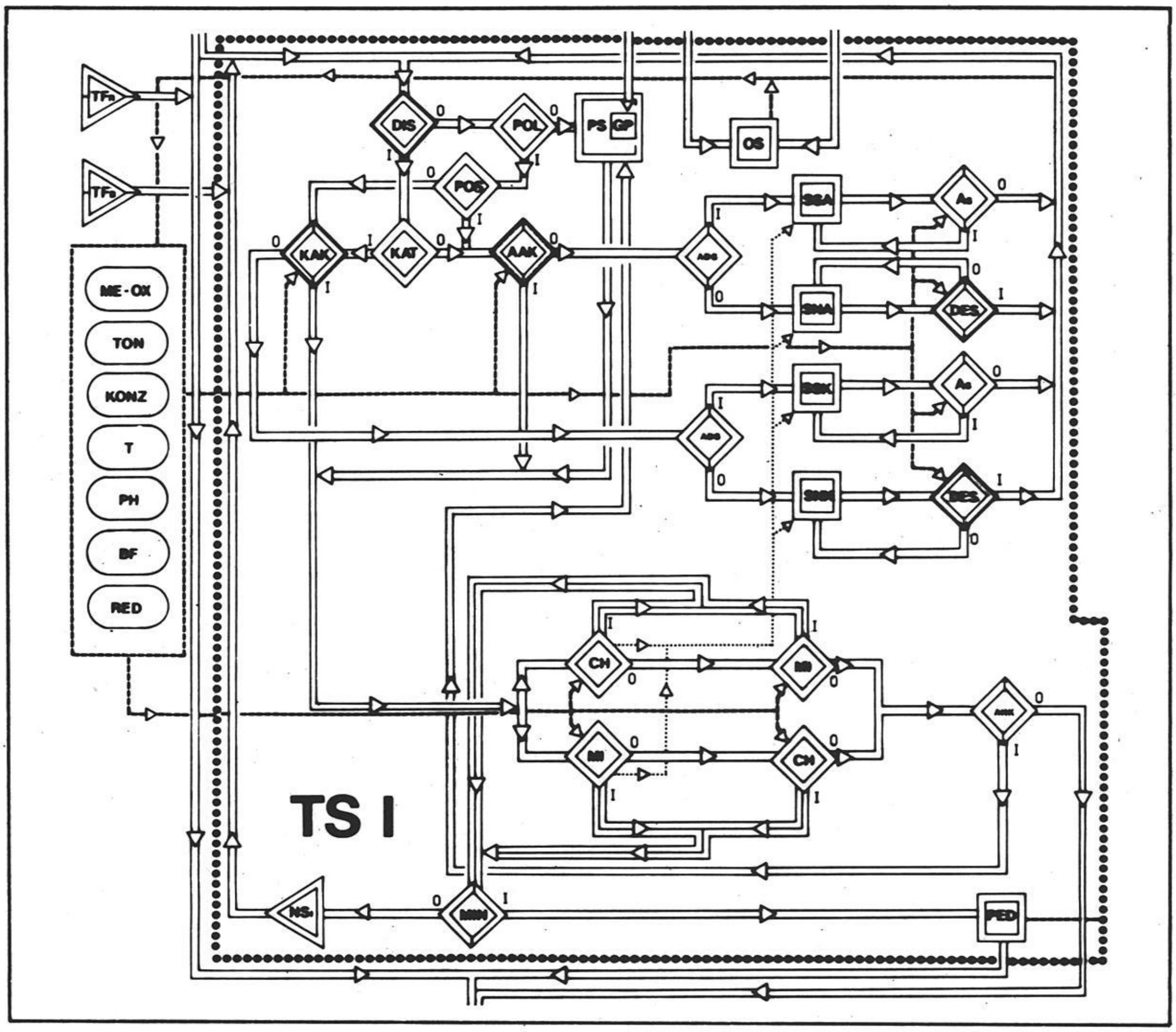
Fluxes of potentially toxic substances through the main environmental compartments (lower) atmosphere, soil-vegetation complex, and water usually have the form of complicated cascading systems. Their analysis has to start with a sufficiently detailed evaluation of the relevant transformation mechanisms and their specific boundary conditions. As far as the soil system, to which the present paper must be restricted, is concerned, they comprise:

- colour, macro and microstructure of soils, horizon sequence, and chemical properties of the individual horizons
- water balance
- moisture and pH controlled cationic and anionic exchange capacities of soil horizons
- diffusion and dispersion phenomena as related to field capacity and actual soil moisture content
- microbial activity

1.1 Regulatory pedophysical and chemical parameters

In greater detail and precision the internal structures and manifold interrelationships of these subsystems can be appropriately represented only in a comprehensive synthetic system model formulated in matrix or in graph forms (FRÄNZLE 1982 b).

Since a reproduction of the complete model is not possible here for technical reasons, a representative section is represented which shows one of the most important transformation subsystems, i.e. TS I.



▷ Input / Output

◇ Regulator

□ Storage element

◯ Physical and chemical boundary conditions

◈ OECD Test guideline available

AAK Anion exchange capacity exceeded?
ADS Adsorbed specifically?
AKK Accumulated?
AS Exchange colloids persistent?
BF Soil humidity
CH Nonbiotically degraded?
DES Desorbed?
DIS Dissociated?
GP Major pores filled with air
KAK Cation exchange capacity exceeded?
KAT Adsorbable due to cationic reactions?
KONZ Concentration of matrix solution
ME-OX Metallic oxides and hydroxides
MI Microbially degrades?
MIN Decomposed?
NSI Newly formed toxic substances
OS Organic matter
PED Pedon
PH PH value
POL Polarized?
POS Sorption to positiv charges?
PS Porous storage
RED Redox reactions
SNA Nonspecific adsorption in anionic form
SNK Nonspecific adsorption in cationic form
SSA Specific adsorption in anionic form
SSK Specific adsorption in cationic form
T Temperature
TFB Throughflow, loaded
TFR Throughflow, unloaded
TON Clay mineral content and composition

Fig. 1: Transformation system I (TS I) as illustrative detail of a comprehensive system model defining the fluxes of a potentially toxic compound through the soil-vegetation complex.

This partial model is to emphasize the importance of adsorption and desorption, which both and in conjunction determine the so-called 'buffering capacity' of a soil. Soil constituents with high specific surface and net charge, i.e. primarily organic matter, then clay minerals and metal oxides and hydroxides, largely determine adsorption and desorption. The relevant boundary conditions are concentration and dissociation or polarity of the chemical on the one hand, soil moisture, temperature, pH value and oxidation and reduction potentials on the other.

The following connectivity matrix (Fig. 2) which is mathematically equivalent to a graph illustrates these interrelationsships in a concise manner.

Controlling parameters \ Parameters influenced	Distribution	Adsorption	Desorption	Decomposition	Soil moisture	Soil fabric	Redox potential	Soil temperature	Mineral composition	Organic matter	Biotic activity	pH value	Petrography	Geomorphological situation
Distribution		1	1	1	4	4	4	0	4	0	4	4	0	0
Adsorption	1		0	0	0	0	0	4	0	0	0	0	0	0
Desorption	1	0		0	0	0	0	4	0	0	0	0	0	0
Decomposition	1	0	0		0	0	0	0	0	0	4	0	0	0
Soil moisture	2	2	2	2		0	3	3	0	0	3	3	0	0
Soil fabric	2	0	0	0	3		3	0	0	0	3	0	0	0
Redox potential	2	2	2	2	0	0		0	3	0	3	3	0	0
Soil temperature	2	2	2	2	0	0	0		0	0	3	0	0	0
Mineral composition	0	2	0	2	0	3	0	3		0	0	0	0	0
Organic matter	0	2	0	2	0	3	0	3	0		3	3	0	0
Biotic activity	0	0	0	2	0	0	0	0	0	3		3	0	0
pH value	2	2	2	2	0	0	3	0	0	0	3		3	0
Petrography	0	0	0	0	0	0	0	0	3	0	0	3		0
Geomorphological situation	0	0	0	0	3	0	0	3	0	0	0	0	0	

1 Primary interactions
2 Secondary interactions
3 Tertiary interactions
4 Impact chemical → Soil

Fig. 2: Connectivity matrix of essential pedochemical interrelationships.

1.2 Soil leaching experiments

In view of the numerous feedback mechanisms operative among these variables systematic search for determining the most important ones and establishing a list of relative priority becomes imperative. To this end laboratory tests by means of larger-scale monolithic lysimeter leaching experiments were run (FRÄNZLE 1982 a). Since these experiments had to be made with saturated soil columns of 60 cm diameter they are simplifications or idealisations from the real world situation. Therefore they were complemented by open-air experiments on podzol and lessivé plots developed from Weichselian cover sand on Saalian moraine and from Weichselian till whose soils are regionally representative for Schleswig-Holstein (FRÄNZLE 1983 b) .

The relevant physical and chemical properties of these experimental soils are summarized in Figures 3 and 4.

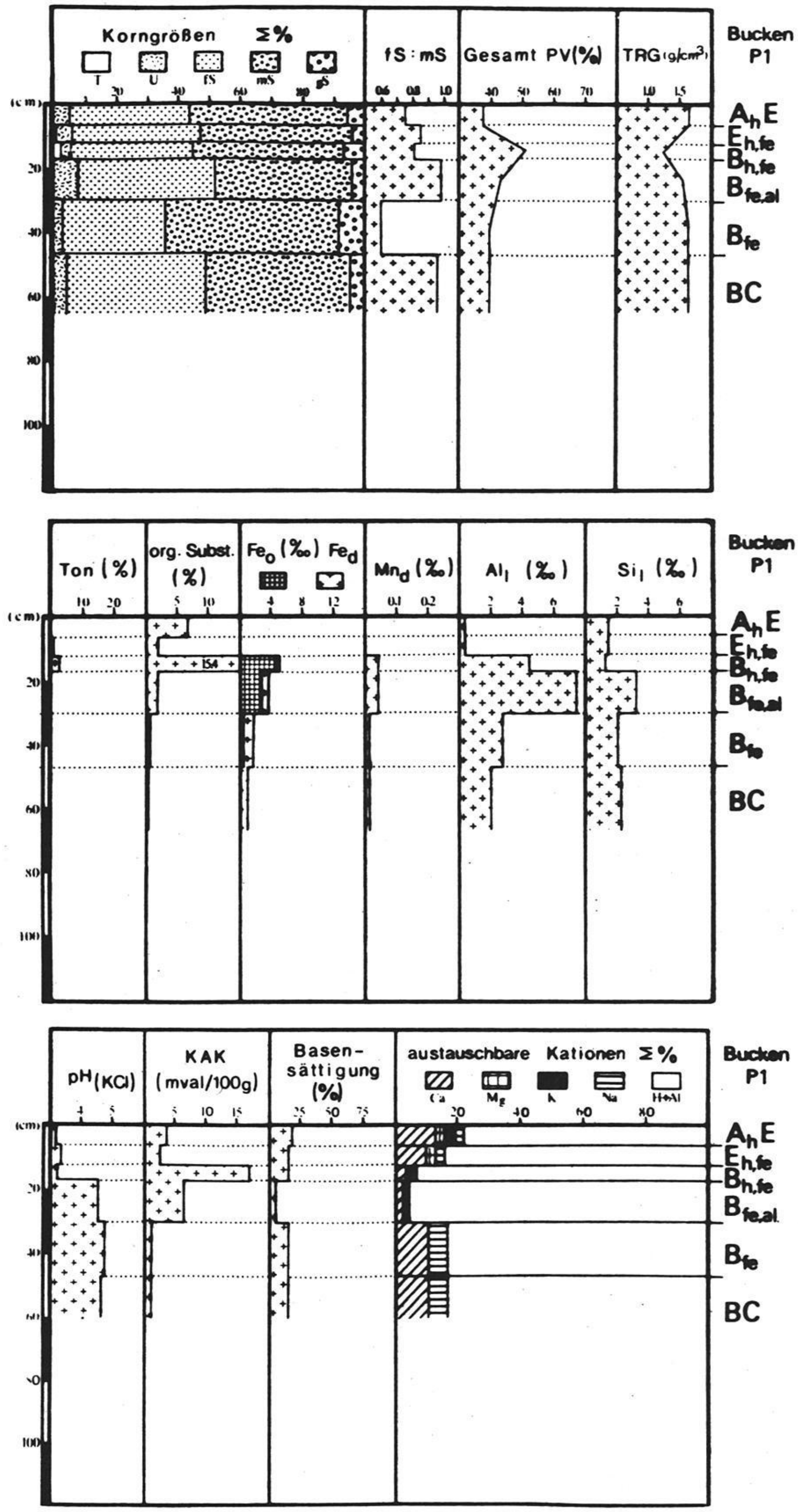


Fig. 3: Chemical and physical characteristics of the Bucken podzol.

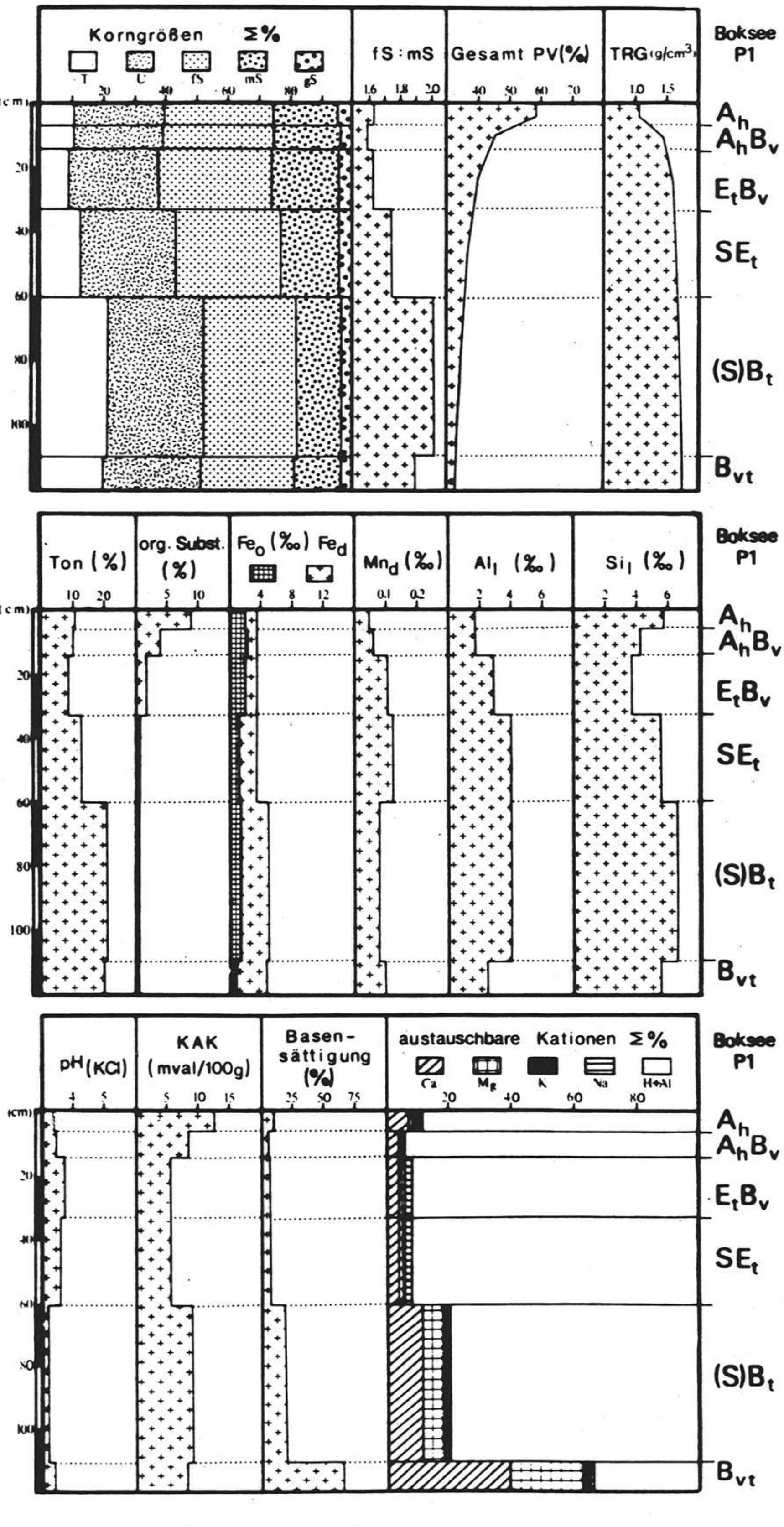


Fig. 4: Chemical and physical characteristics of the Boksee lessivé.

The test substances used for leaching experiments were 2,4-dichlorophenoxyethane acid (2,4-D) and pentachlorophenol (PCP). 2,4-D with a molar mass of 221,04 and an (estimated) world production of 100 000 t/a is used as a herbicide; its partition coefficient n-octanol/water has a log Pow 1,57, the dissociation constant pK_A at 298 K being 2,73. The corresponding figures for PCP which is used as an insecticide, herbicide and fungicide are: molar mass 266,34, world production 25 000 t/a, log Pow 3,69, pK_A at 298 K 4,74. The analytical detection of 2,4-D was made by means of gas chromatography, using a Perkin-Elmer SIGMA 2 B (technical details of equipment in: FRÄNZLE 1982 a); the preparation of samples followed HORNER et al. (1974)

The evaluation of the numerous data obtained from two years' experiments in laboratory lysimeters of the above type and on experimental plots permitted to define the relative importance of the variables involved in sorption processes by means of correlation and regression analysis. As the following Table 1, shows which summarizes only the results of laboratory stirring experiments of sub-horizon samples with 2,4-D (5 g of air-dried soil material / 50 ml solution in the concentrations given in Tab. 1), granulometry, density of soil solid, soil pore fraction, organic matter, oxalate soluble Fe, Al and Si, and pH account for more than 90% of the observed variance of sorption rates as ensues from the following sets of equations.

Table 1: Multiple regressions of sorption rates as a function of chemical concentration and soil properties: A. Boksee P 1, Boksee L 1, Bucken P 1; B. Boksee P 1; C. Bucken P 1.

A.

$V49=-0,07+0,4\ Mn_D+0,001[H^+Alg]-0,03\ Fe_o+0,013\ Al_o+0,004\ OS+0,001[<2\mu m]$	[Mult R=0,93]
$V50=0,09+0,34\ Mn_D+0,001\ OS-0,0004[H^+Alg]+0,005\ Fe_o+0,02\ Si_l+0,001[<2\mu m]$	[Mult R=0,83]
$V51=0,07+0,8\ Mn_D-0,04\ Si_l+0,0005[H^+Alg]+0,006[<63\mu m]+0,016\ Fe_D-0,01[<2\mu m]$	[Mult R=0,67]
$V52=0,2+1,17Mn_D+0,01\ OS-0,1\ Fe_D+0,07\ Al_o+0,02[<2\mu m]+0,023\ Fe_o$	[Mult R=0,73]
$V53=0,4+2,9\ Mn_D+0,004\ OS+0,09\ Al_o-0,002[H^+Alg]-0,04\ Al_l+0,005[<2\mu m]$	[Mult R=0,87]
$V54=2,1-0,03[<63\mu m]-0,04\ OS-0,32\ Al_o+0,45\ Fe_o+0,22\ Si_l-0,008[H^+Alg]$	[Mult R=0,60]
$V55=1,4-12,2\ Mn_D+0,7\ Al_o-0,13\ Al_l+0,05\ Fe_o+0,04[<63\mu m]+1,4\ Fe_D$	[Mult R=0,83]
$[V58=3,5+0,1\ OS+0,73\ Al_o-1,06\ Fe_D+0,2[<2\mu m]+0,25\ Fe_o+0,005[H^+Alg]$	[Mult R=0,89]

B.		C.	
$V49=-0,083+0,1\ Al_o+0,01\ Si_l$	[Mult R=0,95]	$V49=0,01-0,008[<2\mu m]+0,003[<63\mu m]$	[Mult R=0,98]
$V50=0,13-0,01\ OS-0,01\ Al_l$	[Mult R=0,8]	$V50=0,06+0,03[<2\mu m]-0,006[<63\mu m]$	[Mult R=0,98]
$V51=0,33-0,06\ Si_l+0,18\ Al_o$	[Mult R=0,74]	$V51=0,13+0,13[<2\mu m]-0,02\ OS$	[Mult R=0,98]
$V52=0,24+0,05\ Al_l-0,03\ Fe_D$	[Mult R=0,82]	$V52=0,01+0,04[<63\mu m]+0,04[<2\mu m]$	[Mult R=0,71]
$V53=0,54-0,009[H^+Alg]+0,9\ Al_o$	[Mult R=0,88]	$V53=0,14+0,06\ Fe_D+0,008[<63\mu m]$	[Mult R=0,98]
$V54=2,27-2,06\ Al_o+0,013[H^+Alg]$	[Mult R=0,71]	$V54=1,54+0,4[<2\mu m]-0,1\ Fe_D$	[Mult R=0,74]
$V55=0,99-14,2\ Mn_D+1,21\ Al_o$	[Mult R=0,88]	$V55=4,3+0,4[<63\mu m]-0,06[H^+Alg]$	[Mult R=0,95]
$[V58=3,49+0,009[H^+Alg]-2,8\ Mn_D$	[Mult R=0,96]	$[V58=2,5+0,4[<63\mu m]-0,4\ Si_l$	[Mult R=0,98]

$[H^+Alg]$ = Variable 9; $[H^+Al_{45}]$ = Variable 45

V 49	Amount of 2,4-D adsorbed at concentration	$C_O = 0,1$ g/l
V 50	Amount of 2,4-D adsorbed at concentration	$C_O = 0,2$ g/l
V 51	Amount of 2,4-D adsorbed at concentration	$C_O = 0,5$ g/l
V 52	Amount of 2,4-D adsorbed at concentration	$C_O = 1,0$ g/l
V 53	Amount of 2,4-D adsorbed at concentration	$C_O = 2,0$ g/l
V 54	Amount of 2,4-D adsorbed at concentration	$C_O = 4,0$ g/l
V 56	Amount of 2,4-D adsorbed at concentration	$C_O < 2,0$ g/l
V 57	Amount of 2,4-D adsorbed at concentration	$C_O > 2,0$ g/l
V 58	Total amount of 2,4-D adsorbed at concentration	C_O

Al_l	Al in soil extract
Al_O	Oxalate soluble AL
Fe_D	Dithionite soluble Fe
Fe_O	Oxalate soluble Fe
H+Alg	Sum of exchangeable cations in %
Mn_D	Dithionite soluble Mn
OS	Organic matter in %
Si_l	Si in soil extract
Mult R	Multiple regression coefficient

2. Geostatistical interpretation of geological, pedological and topographic maps

The relationships summarized in Table 1 permit, to a certain extent, a sorption-oriented interpretation of the areal data contained in large and middle-scale maps of a region relating to the geological, geomorphological, pedological and topographic situation.

2.1 Basic principles of evaluation and data transformation

In the context of the present paper the 1:25 000 geological, petrographic, pedological and topographic maps of a Saalian moraine complexe with Weichselian cover sands (c.f. plot Bucken) southwest of Kiel (Schleswig-Holstein) were analyzed. For this purpose each sheet was subdivided into 3249 grid points. The relevant cartographic information at each point and its immediate neighbourhood relating to sedimentology (e.g. till, cover sand, peat), substrate (sand, silt, clay, etc.), soils (category label: soil group), relief (i.e. exposition and slope angle classes), and land use was transformed into nominal data.

After an appropriate reduction of the prohibitive number of primary data thus obtained by using representative neighbourhood relationships, cluster analysis in the form of entropy analysis (ANDERBERG 1973, WILLIAMS & LANCE 1966) was the method of evaluation.

2.2 Entropy analysis and areal classification procedures

Entropy analysis is based on the information theoretic concept of entropy (SHANNON & WEAVER 1949) and defines measures of association between nominal or binary variables such that the information loss suffered in conversion to binary data is somewhat compensated by additional advantages. The aggregation of the binary data is accomplished by a centroid sorting procedure (ANDERBERG 1973). This clustering method employs heuristic devices for adjusting the number of clusters to conform to the apparent natural structure of the data set (VOGEL 1975).

Three of the most prominent motivations for allowing the number of clusters to vary are (i) entropy increase, (ii) spatial diversity of the area depicted, and (iii) specific interactions of a selected chemical with the environment. In the present framework sorting the data set into 7 clusters (i.e. geopedological units) appears optimal, 10 introducing an element of useless complexity on the one hand, and 5 yielding poorly defined clusters on the other, which would not permit a sufficiently precise chemical hazard assessment (HOFFMANN 1982).

The result of entropy analysis is summarized in the following computer map. The broken lines indicate associations of the above geopedological units in order to make the spatial structure more easily discernible, while the legend explains the units in terms of environmental criteria according to Fig. 2.

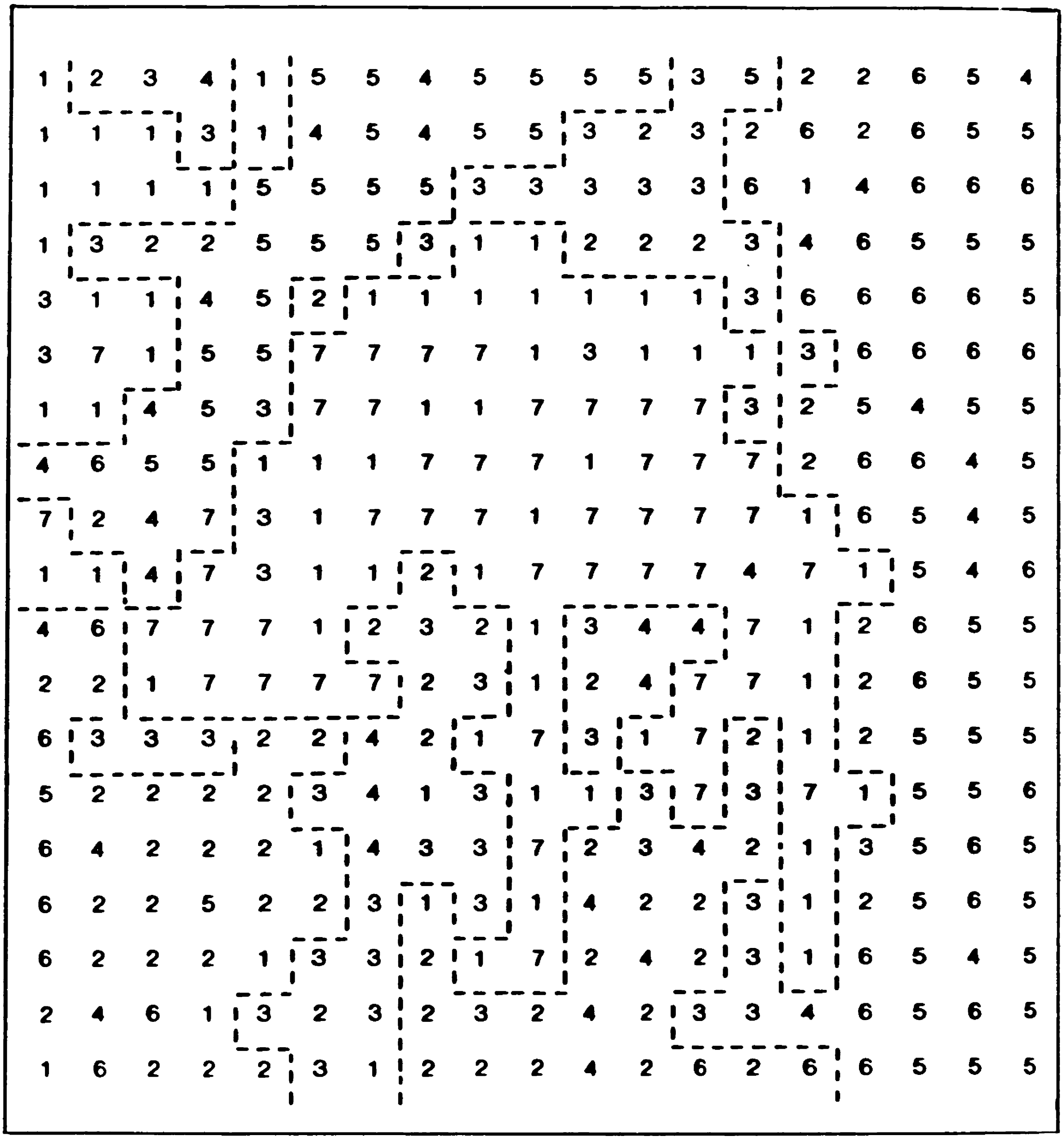
2.3 Assessment of buffering capacities

Geopedological units of the above type are homogeneous entities in the precise operational sense of cluster algorithms or entropy analysis, respectively. Hence each unit may be expected to display specific reactions to defined chemical impacts. In addition to Figure 2, which shows the essential relationships between physico-chemical characteristics of a compound and its distribution properties, Table 2 summarizes in an analogous way the relevant systemary relations between pedological parameters of a potentially affected soil and the environmental chemical characteristics of a compound released.

Table 2: Relationships between pedological parameters and distribution characteristics.
V = Distribution, S = Sorption, D = Decomposition

	V	S	D
Fabric	x	o	o
Mineralogical composition	o	x	x
Temperature	x	x	x
Aeration/Redox potential	x	x	x
Microbial activity	o	o	x
Organic matter	o	x	x
Soil moisture	x	x	x
ph-value	x	x	x

The information contained in Table 1 and Figure 2 forms the basis of the concluding exemplary assessment of the different buffering capacities of the above geopedological units in regard to the agrochemical 2,4 dichlorophenoxyethane acid which appears in anionic form in the environment. In the following Table 3 the possible interactions of each unit are labelled positive (+), negative (-) or indifferent (0) in order to indicate reducing or annihilating, intensifying or accelerating, or imperceptible reactions of the soil-vegetation-relief complex to the chemical impact. The sum of these positive and negative effects is deemed indicative of the buffering capacity



(1) Podzol and Humic Podzol from sandy till on marked to very pronounced slopes facing west and southeast: arable land and broad-leafed forest.
(2) Podzol and Humic Podzol from sandy till and fluvioglacial deposits on medium slopes facing to northeast to east and on hilltops; arable land.
(3) Surface water gley (Pseudogley) and Podzol (pp. Lessive) from clayey to sandy till on moderate to steep slopes facing northwest and southwest; arable land and grassland.
(4) Peaty ground, low fen in valley bottoms; grassland and arable land.
(5) Humic podzol and peaty ground on level fluvioglacial sands; grassland and arable land.
(6) Humic (pp. peaty) Podzol from fluvioglacial sands in valley bottoms and on subordinate slopes; arable land and grassland.
(7) Orthic Podzol from sandy till on hilltops, steep slopes and in valleys with highly variable exposition; arable land and broad-leafed forest.

Fig. 5: Computer map of the distribution of 7 geopedological units resulting from entropy analysis.

Table 3: Relationships between pedological parameters of 7 geo-pedological units and chemicals properties of 2,4-D. V = Distribution, S = Sorption, D = Decomposition.

	1			2			3			4			5			6			7		
	V	S	D	V	S	D	V	S	D	V	S	D	V	S	D	V	S	D	V	S	D
Fabric	-			-			+			+			+			-			-		
Mineralogical composition		+	-		+	-		+	+		-	-		+	-		+	-		+	-
Temperature	0	+	+	0	+	+	0	+	+	0	-	-	0	-	-	0	-	-	0	-	+
Aeration/ Redox potential	0	+	+	0	+	+	0	+	+	0	-	-	0	-	-	0	+	-	0	+	+
Microbial activity			-			-			-			-			-			-			-
Organic matter		+	-		+	-		+	-		+	+		+	+		+	+		+	-
Soil moisture	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
pH-value	+	+	-	+	+	-	+	+	-	0	+	-	+	+	-	+	+	-	+	+	-
Geomorphological situation		+			-									-			+				
Total positive	8(9)			8			12			4			6			6(7)			7		
Total 0	2			2			2			3			2			2			2		
Total negative	8			8(9)			4			11			10(11)			10			9		
Relative buffering capacity	6			5			7			1			2			3			4		

or resilience of each unit which is thus defined on the relative level of an ordinal scale. In a few critical cases additional information was drawn from the geomorphological situation.

The buffering capacities of the 7 geopedological units with regard to 2,4-D decrease in the form of the following sequence:

$$3 > 1 > 2 > 7 > 6 > 5 > 4$$

A transformation of this ordinal sequence to the level of a metric scale (i.e. kg/ha) appears possible by means of adsorption isotherms of the FREUNDLICH or LANGMUIR types. Their determination must be based on a comprehensive set of samples such that the essential requirements of a spatially representative distribution are met (FRÄNZLE 1983 b). Also in this case, however, quantifications can only be made for specific compounds or elements, respectively, and it is one of the major tasks to widen the knowledge in this realm of environmental chemistry. In comparison to cationic substances existing knowledge in the practically very important field of anionic compounds is still regrettably limited because of the inherent difficulties the example chosen was to illustrate. But the greater is the challenge.

2.4 Possibilities of pedological and environmental chemical interpretations of geomorphological maps

In view of the preceding evaluation the question arises to which extent detailed geomorphological maps of the GMK 25 type permit analogous interpretation. While the answer is almost trivial with respect to the morphographic, morphometric and petrographic informations which can easily be combined in the way described other relevant facts can only be deduced by means of specific interpretation techniques. BARSCH & MÄUSBACHER (1980) and MÄUSBACHER (1983) demonstrated the possibilities with respect to soil erodibility, field capacity and other elements of the moisture regime in a conclusive way. FRÄNZLE (1982 c) discussed ways to predict the potential distribution of environmental chemicals in terms of the filtering and buffering capacities of soils and sediments.

Several comparative analyses of the soil distribution in the area covered by the GMK 25 sheet 8, 1826 Bordesholm (FRÄNZLE 1981) and in adjacent regions (KNEIB 1979, MUTERT 1978) showed that quite limited a number of precise pedo-regional levés in representative sites or site complexes, respectively, allow to define the relevant pedogenetic factors and corresponding pedofunctions with a sufficient amount of accuracy. On such a basis it is then well possible to produce reliable soil maps in a comparatively speedy way if additional areal information is available, e.g. in the form of detailed geomorphological maps. But even in the worse case that large-scale soil maps are lacking the geopedologically oriented interpretation of the relevant petrographic, granulometric and morphographic informations of geomorphological maps yields approximate, but nevertheless valuable insights into the filtering and buffering capacities of soils and sediments.

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Geomorphic interpretation of the Geomorphological Map of the Federal Republic of Germany (GMK 25)

with 7 Figures and 1 Table

DIETRICH BARSCH

A b s t r a c t: During the last years the discussion of the GMK 25 has been focussed on the importance of these geomorphological maps for other earth sciences and for planning purposes. In the present paper the importance of the data and information documented in now 17 sheets of the GMK 25 for our proper science will be demonstrated by a few examples. It can be concluded that the geomorphological observations displayed on these maps are of great help in order to check a geomorphological hypothesis or in order to enlarge the number of examples for a new theory.

Die geomorphologische Interpretation der Geomorphologischen Karte der Bundesrepublik Deutschland (GMK 25)

K u r z f a s s u n g: Neben der Bedeutung der geomorphologischen Karte 1 : 25 000 der Bundesrepublik Deutschland für Nachbarwissenschaften und Praxis ist das wissenschaftliche Gewicht des GMK 25 Kartenwerkes für das eigene Fachgebiet weniger diskutiert worden. An einigen Beispielen wird gezeigt, daß in den jetzt vorliegenden 17 Karten der GMK 25 ein großer Informationsgehalt liegt. Der in den verschiedenen Blättern dokumentierte Schatz an geomorphologischen Beobachtungen ist noch nicht andeutungsweise ausgeschöpft worden. Diese Fülle an Beobachtungen kann einmal zur Überprüfung von neuen Hypothesen, zum anderen zur Erweiterung der neuen Theorien zugrunde gelegten Fakten dienen.

L'interpretation géomorphologique de la Carte Géomorphologique 1 : 25 000 de la République Fédérale d'Allemagne (GMK 25)

R é s u m é: Pendant les années passées la discussion était centrée à l'importance de la carte géomorphologique détaillée pour les autres sciences de la terre et pour l'aménagement du territoire. Un peu négligé était le fait que la carte géomorphologique détaillée a aussi une grande importance pour notre propre science, la géomorphologie. Par quelques exemples il est démonstré que dans les 17 cartes géomorphologiques de la GMK 25 déjà publiées il y a beaucoup d'informations pour des autres géomorphologues. Spécialement pour vérifier une hypothèse géomorphologique ou pour agrandir le base des observations géomorphologiques les cartes géomorphologiques détaillées de types GMK 25 peuvent être d'une grande importance.

C o n t e n t s

1. Introduction

At midsommer 1985 17 examples of the GMK 25 (BARSCH & LIEDTKE 1980) will have been printed (Tab. 1 and Fig. 1). They comprise very different geomorphic regions of the Federal Republic of Germany, Central Europe. In addition, our method has been sucessfully applied in other areas; for

instance in northern Ellesmere Island (MÄUSBACHER 1981), in southern Italy (SEILER 1982) or in southern France (FARRENKOPF, submitted).
Up to now most of the discussion has been concentrated – on the method established,
- on possibilities using our legend in other geomorphic regions
- and on the possible use of the informations and data displayed in these maps by other geosciences and by planners.

But our project has expecially been started as a challenge for the development of geomorphology, our proper science. Besides the standardization of geomorphic terminology and a new systematic collection of field data the program aimed at an objective display of geomorphic information on maps (BARSCH 1976). Therefore, it seems also important to discuss the geomorphic interpretation of these maps; that is the use of these data and information by other geomorphologists.

Table 1: The geomorphological Map (GMK 25) of the Federal Republic of Germany.

GMK Nr.	GMK Name	TK 25 Nr.	Relief	Land	Author	printed
1	Borhöved	1927	Weichselian endmoraine on the North German plain	Schleswig-Holstein	J.W. Scheel	1978
2	Wetter	5018	Mountaineous relief in Bunter sandstone	Hessen	J. Gehrenkemper K. Möller G. Stäblein	1978
3	Mannheim-Nordost	6417	Alluvial plain in the Rheingraben	Baden-Württemberg	D. Barsch R. Mäusbacher	1979
4	Wehr	8313	Mesas and valleys at the southern rim of the Black Forest	Baden-Württemberg	H. Leser	1979
5	Damme	3415	Saale moraines on the North German Plain	Niedersachsen	P.U. Galbas P.M. Klecker H. Liedtke	1980
6	Bad Iburg	3814	Plains and cuestas in Westfalia	Nordrhein-Westfalen	L. Hempel	1981
7	Salzhemmendorf	3923	Hogbacks and cuestas in the Weser Mountains	Niedersachsen	F. Lehmeier	1981
8	Bordesholm	1826	Weichselian moraines on the North German plain	Schleswig-Holstein	O. Fränzle B. u. W. Haase	1981
9	Mössingen	7520	Cuestas and mesas in southern Germany	Baden-Württemberg	H. Leser	1982
10	Wangerooge	2213	Tidal flats and islands in Eastern Frisia	Niedersachsen	J. Ehlers H. Mensching	1982
11	Bingen	6013	Southern part of the Rheinische Schiefergebirge and the middle Rhein Valley	Rheinland-Pfalz	W. Andres O. Kandler J. Preuss	1983
12	Edenkoben	6714	Mountains and foothills at the Western rim of the Rheingraben	Rheinland-Pfalz	G. Höhl I. Dörrer	1983
13	Berlin-Zehlendorf	3545	Weichselian Moraines at the North German Plain	Berlin	H.J. Pachur G. Schulz	1983
14	Oberstaufen	8426	Alpine Relief	Bayern	H. Dongus	1983
15	Saarburg	6305	Fluvial terraces	Rheinland-Pfalz	M. Müller	1984
16	Königssee	8443	Alpine relief	Bayern	K. Fischer	1984
17	Bad Sooden-Allendorf	4725	Mountaineous terrain	Hessen	K. Möller G. Stäblein	1984

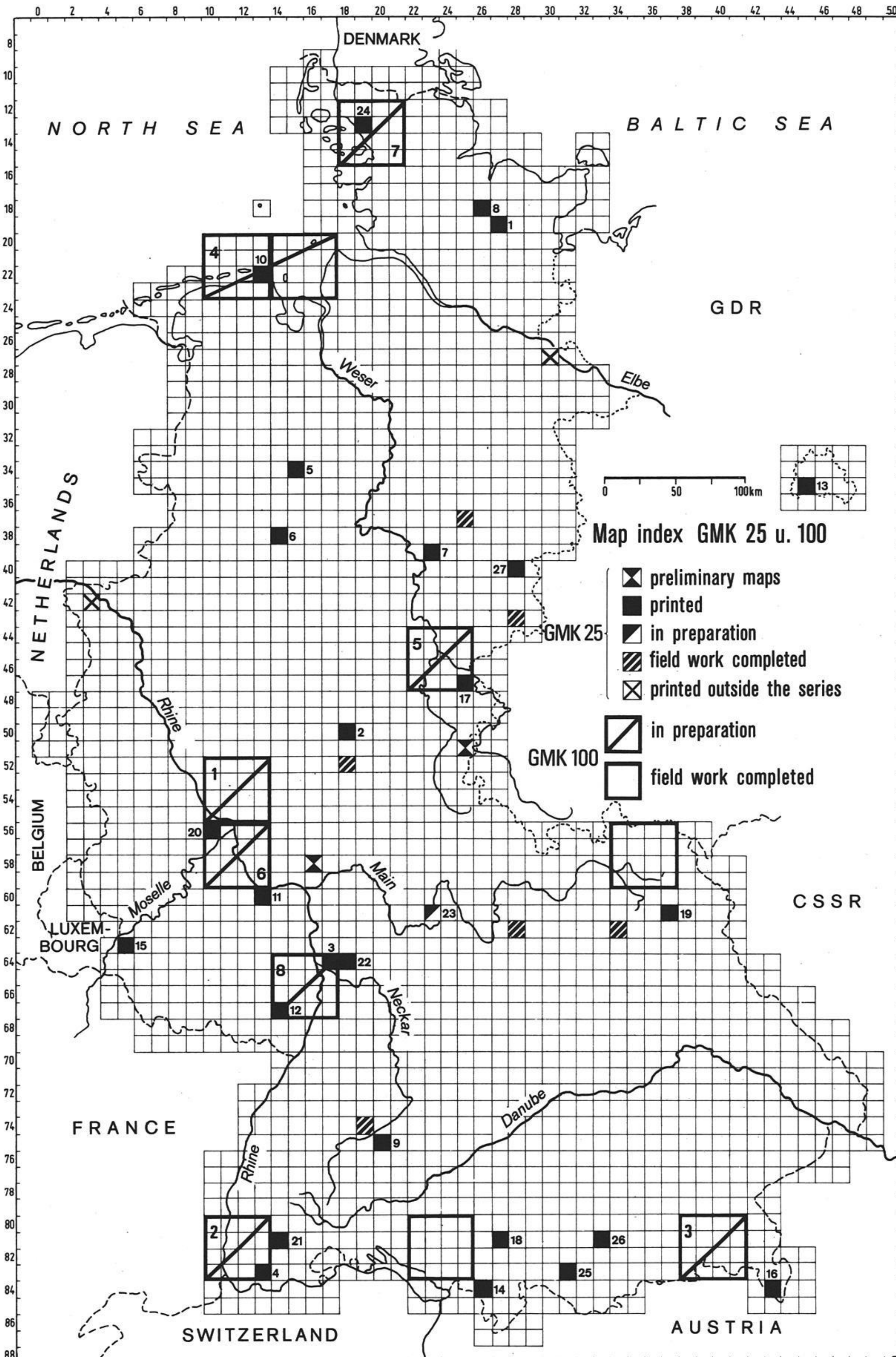

Fig. 1: Mapped sheets of the GMK 25 and GMK 100.

2. Statistical evaluation

In a special effort coordinated by Professor VINKEN (Hannover) and sponsored by the Deutsche Forschungsgemeinschaft (German Research Foundation, Bonn) most geosciences are trying to develop digital maps. The geomorphological maps already published can be used as a first approach for a digital geomorphic base map (BARSCH & STÄBLEIN 1978, BARSCH & SCHUSTER 1981). That is, their scientific content as well as their terminology will give the main structure for the new data bank. Naturally, the data bank or the digital geomorphic base map will contain more data and informations concerning the relief and the geomorphic processes than the geomorphological map 1 : 25 000 (GMK 25) itself.

On the other hand, the different sheets of the GMK 25 contain already a plurality of information which can be digitised and treated statistically. A number of interesting results is possible regarding the relations between slope angle and present-day geomorphic processes, between substrate and slope stability etc. .A broad field of exciting applications is thinkable; it shall not be discussed here, because this paper is concentrated on some examples of a direct geomorphic interpretation of the GMK 25.

3. Interpretation examples

3.1 Fluvial geomorphology

On sheet 3 Mannheim-Nordost (BARSCH & MÄUSBACHER 1979) the late Würmian bed of the Neckar river has been mapped (Fig. 2). There are still more than 15 km of meanders and former oxbow lakes formed more than 10 000 years ago. According to BARSCH & MÄUSBACHER the basal peat has a ^{14}C-age of 11 000 years. This demonstrates that in the Rheingraben in those days the late glacial rivers were no longer braided but meandering.

As it is known in fluvial geomorphology, the shape of the river bed allows some calculations regarding the meander geometry. The meander radius of this old Neckar river bed varies between 0,5 and 0,7 km, the meander length between 2 and 2,5 km.

Despite the fact that most parts of the meander problem is still only qualitatively solved some formula are existing which are supposed to be of certain validity. According to ZELLER (1967, MANGELSDORF & SCHEUERMANN 1970:139ff) the following equation normally fits well:

$$l_M = K_1 \cdot Q^{C_1}$$

l_M : length of meander (m)
K_1 : coefficient (varies between 50 and 65)
Q : bankfull discharge ($m^3 s^{-1}$)
C_1 : coefficient (ca. 0,5)

Solving the equation for Q (with C_1 = 0,5):

$$Q = \left(\frac{l_M}{K_1} \right)^2$$

Assuming the boundary conditions for K_1 (50 and 65) to be correct Q amounts to:

$$1\,500 \text{ m}^3 \text{ s}^{-1} < Q < 2\,500 \text{ m}^3 \text{ s}^{-1}$$

According to the published cross profiles (position given in the map) a bankfull discharge of 1 500 to 2 500 m^3 s^{-1} had to have a flow velocity of 1,2 to 2 m s^{-1}, a pretty realistic value.

Today the mean flood discharge of the Neckar is around 1 200 $m^3 s^{-1}$, whereas the maximum flood discharge has been calculated to be 2 500 $m^3 s^{-1}$ (30.10.1824) at Rockenau 61,4 km above the mouth of the river (KELLER 1979). These discharge values are difficult to compare; assuming a bankfull discharge once a year the mean flood discharge was higher, perhaps partly considerable higher, during the late Würm than today.

The area discussed could be a place or could be at least one example for starting a study on late Würm fluvial discharge. A comparable example for glacifluvial discharge from a decaying inlandeis can be found on sheet 1 (Bornhöved) of the GMK 25 (Fig. 3). There, the box shaped valley of the Tensfelder Au has been formed as a meltwater channel, which was cut in a well developed outwash plain. This outwash plain was built up during the main advances of the last glaciation.

3.2 Coastal geomorhpology

On sheet 10 of the GMK 25 (EHLERS & MENSCHING 1982) one example of the East Frisian string of islands has been mapped (Fig. 4). It is situ-

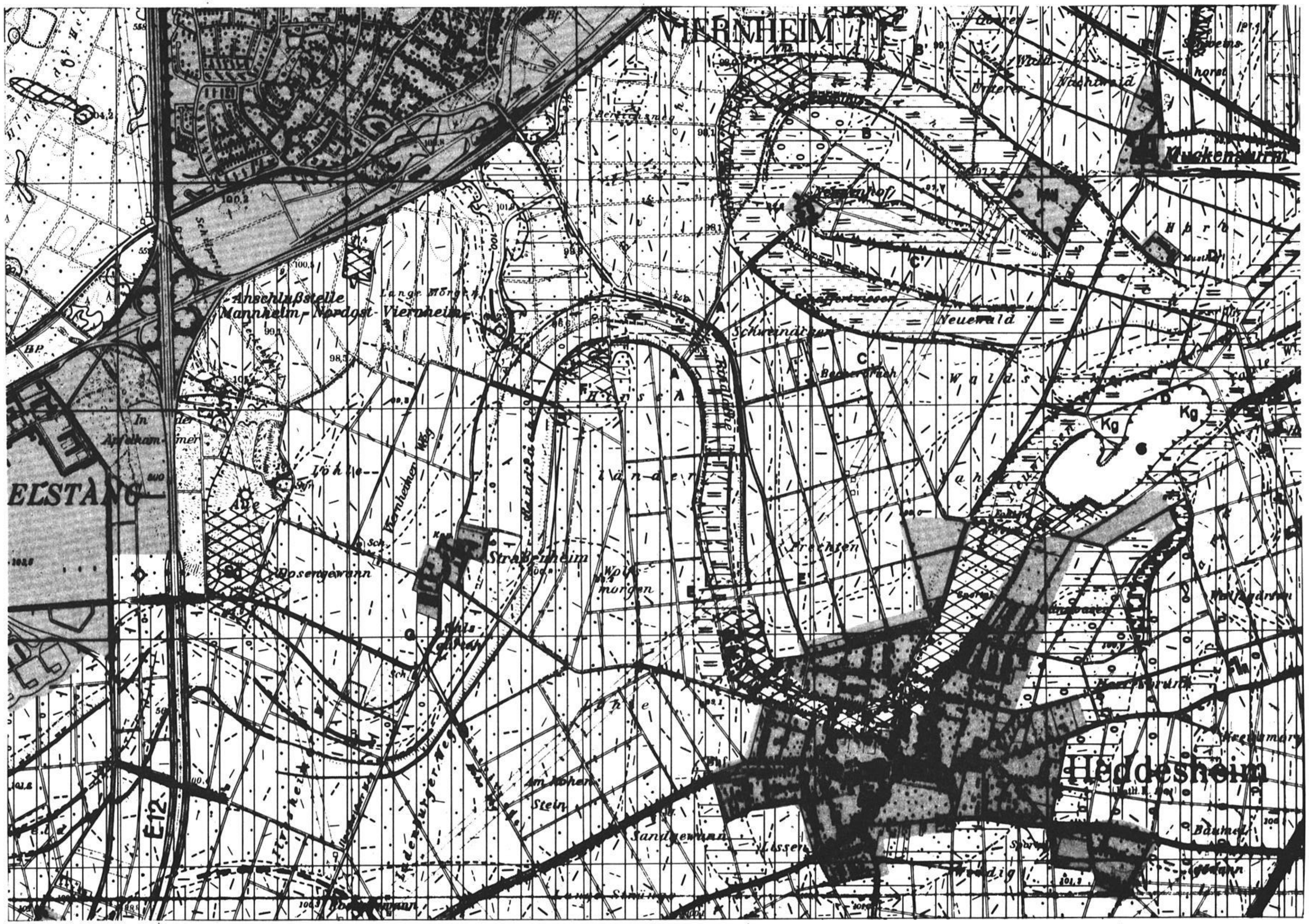

Fig. 2: Meanders of the late Würmian Neckar-River (from: GMK 25.Blatt 3, Mannheim-Nordost).

Fig. 3: Meltwater channel in the Tensfelder Au (from: GMK 25 Blatt 1, Bornhöved).

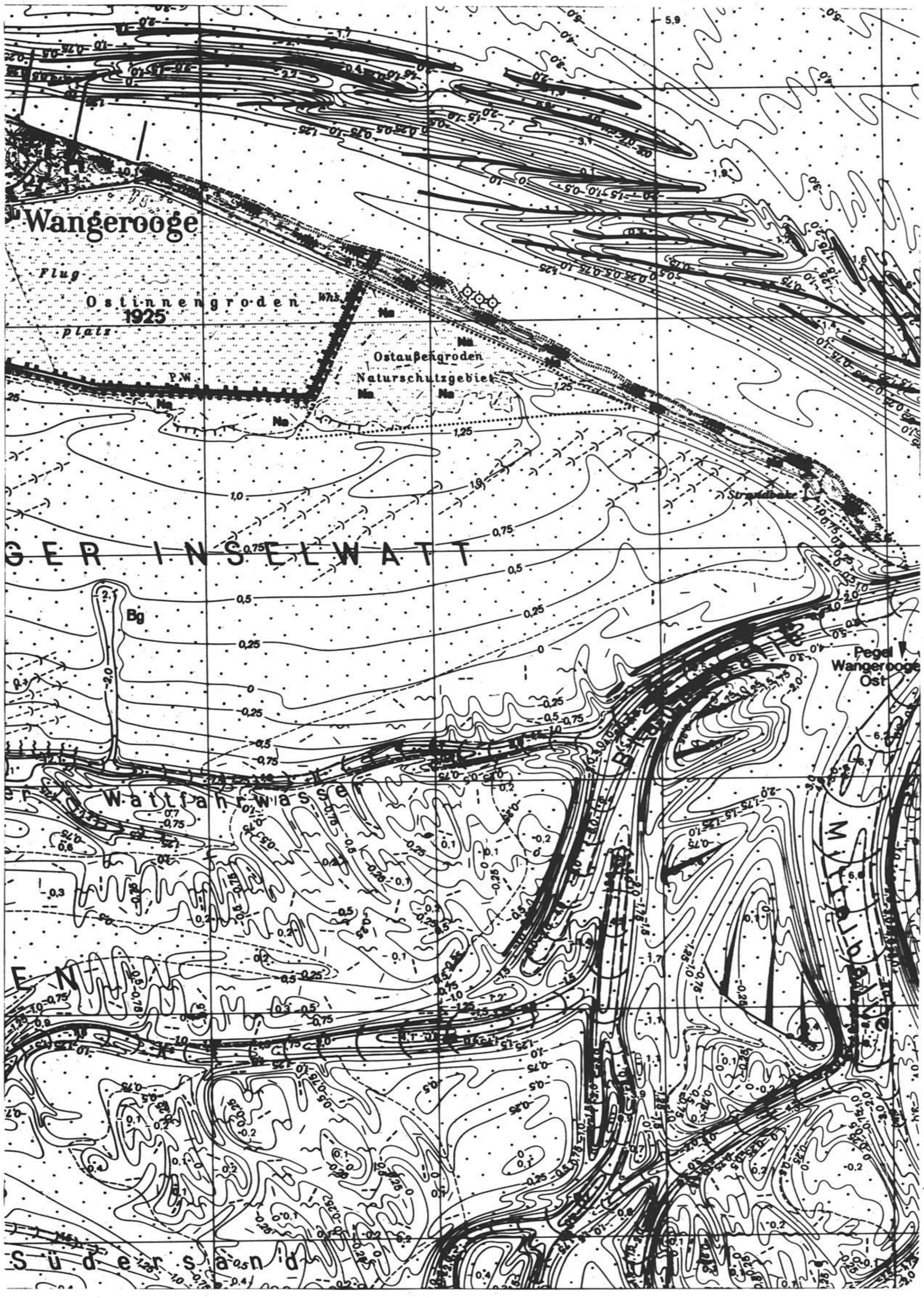

Fig. 4: Eastern part of the Wangerooge Island (from: GMK 25 Blatt 10, Wangerooge).

ated at the edge of the tidal flat towards the North Sea. Between the marshland of the mainland and the island Wangerooge two great systems of subsea channels are developed. Twice a day the seawater streams in- and outward through these channels. Their geometry may be a base for a calculation of the sediment balance in this area.

The island itself is formed by dike protected marshlands and by a chain of old dunes. Seaward there are - especially at the northeast coast - broad sand flats, where during low water deflation occurs and from which sand is blown towards the island. The whole system is slowly shifting towards the east, which causes a number of problems (EHLERS & MENSCHING 1982).

3.3 Cuestas and periglacial talus

In the southeast quadrangle of sheet 9 Mössingen of the GMK 25 (LESER 1982) the Malm (upper Jura) cuesta has been mapped (Fig. 5). The cuesta front slope (limestone) is about 30-50 m high and normally steeper than 35°. Like in the Swiss Jura (BARSCH 1969) these slopes are only slightly (± 30-50 cm) or not at all covered by talus, probably of periglacial origin.

The socle material of the cuesta (Jurassic marls and clays) is not directly exposed. It is covered by Pleistocene periglacial talus. In the upper part of the socle slope (15-35°) the talus is relatively thick and forms a true talus slope which normally masks the contact between the limestone and the marls. In the lower parts of the socle slope (ca. 7-15°) the displacement of talus and marls by solifluction becomes more and more important for the form of the slope. The present slope seems to be stable under the present day climatic conditions. There are no indications for active geomorphic processes like landsliding, rill or sheet erosion. That is, the mapped slope profile has to be interpreted as a periglacial one. It may be used as an example for periglacial slope profiles in southern Germany, which have been only slightly changed during the Holocene and which display the famous periglacial concave slope profile (BARSCH 1983).

3.4 Fluvial history

On sheet 11 Bingen of the GMK 25 (ANDRES, KANDLER &PREUSS 1983) the Rhine enters the Rheinische Schiefergebirge, a mountaineous threshold blocking the south to north flowing river (Fig. 6). Today a western tributary, the Nahe river, joins the main stream just inside the mountains. The Rochusberg, which divides the two rivers, has been separated by a narrow gorge from the Rheinische Schiefergebirge.

The situation seems paradoxical because towards the south the Rheingraben displays a suitable ground for the two rivers to join. This demonstrates that the junction of both rivers is older than the uplift of the Rheinische Schiefergebirge. It is a place where the antecedence of Rhine and Nahe is proven by the relief.

3.5 Relief development at the western edge of the Rheingraben.

At the latitude of Karlsruhe the Rheingraben is bordered by the Pfälzer Wald. The main fault divides the Bunter Sandstone (to the West) from younger rocks. On sheet 12 Edenkoben of the GMK 25(HÖHL & DÖRRER 1983) the foothills are sloping from the foot of the Pfälzer Wald towards the Rhine (Fig. 7). The upper parts are supposed to be denudational; they are limited by steeper, periglacially formed slopes, which mark the step to the lower, mostly loess covered slopes. These upper parts give the impression of pediments, as demonstrated by STÄBLEIN (1968). The GMK 25 Edenkoben displays the geometry of these features, which must have been formed under other climatic conditions than today.

4. Conclusion

The hitherto published examples of the GMK 25 are not covering huge areas; nevertheless, they display quite a number of informations expecially on the geometry of the discussed forms. These informations can and shall be of use for other geomorphologists; they can furnish an enlargement of his own field data. Furthermore, they allow an easy check of a new hypothesis or a new model or they can be used as additional examples in teaching geomorphology.

The examples given are just a crude, first step, but they demonstrate the possibilities of a broader use of geomorphological maps in our science proper.

Fig. 5: Malm cuesta near Mössingen (from: GMK 25 Blatt 9, Mössingen).

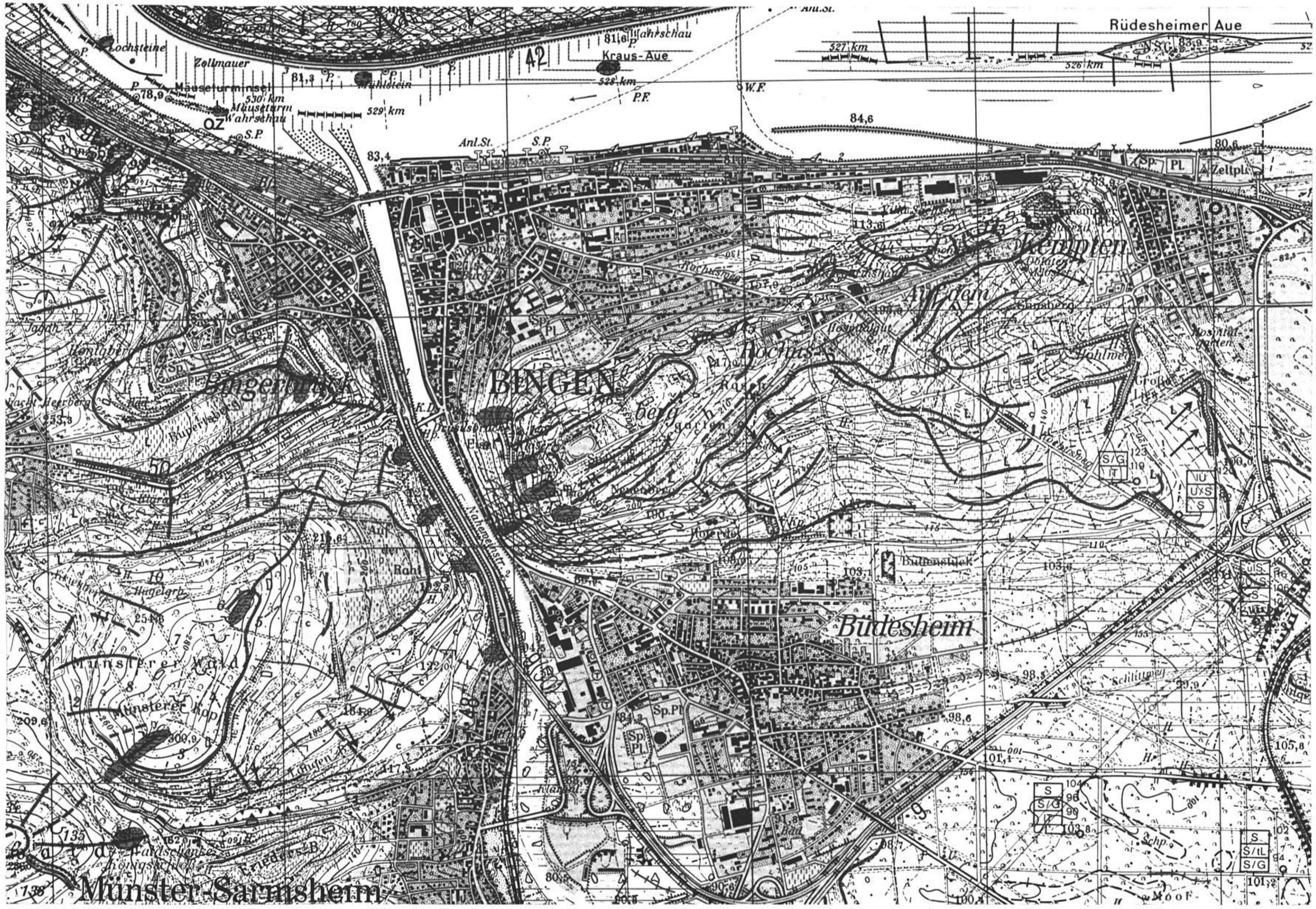

Fig. 6: Antecedent Nahe valley near Bingen (from: GMK 25 Blatt 11, Bingen).

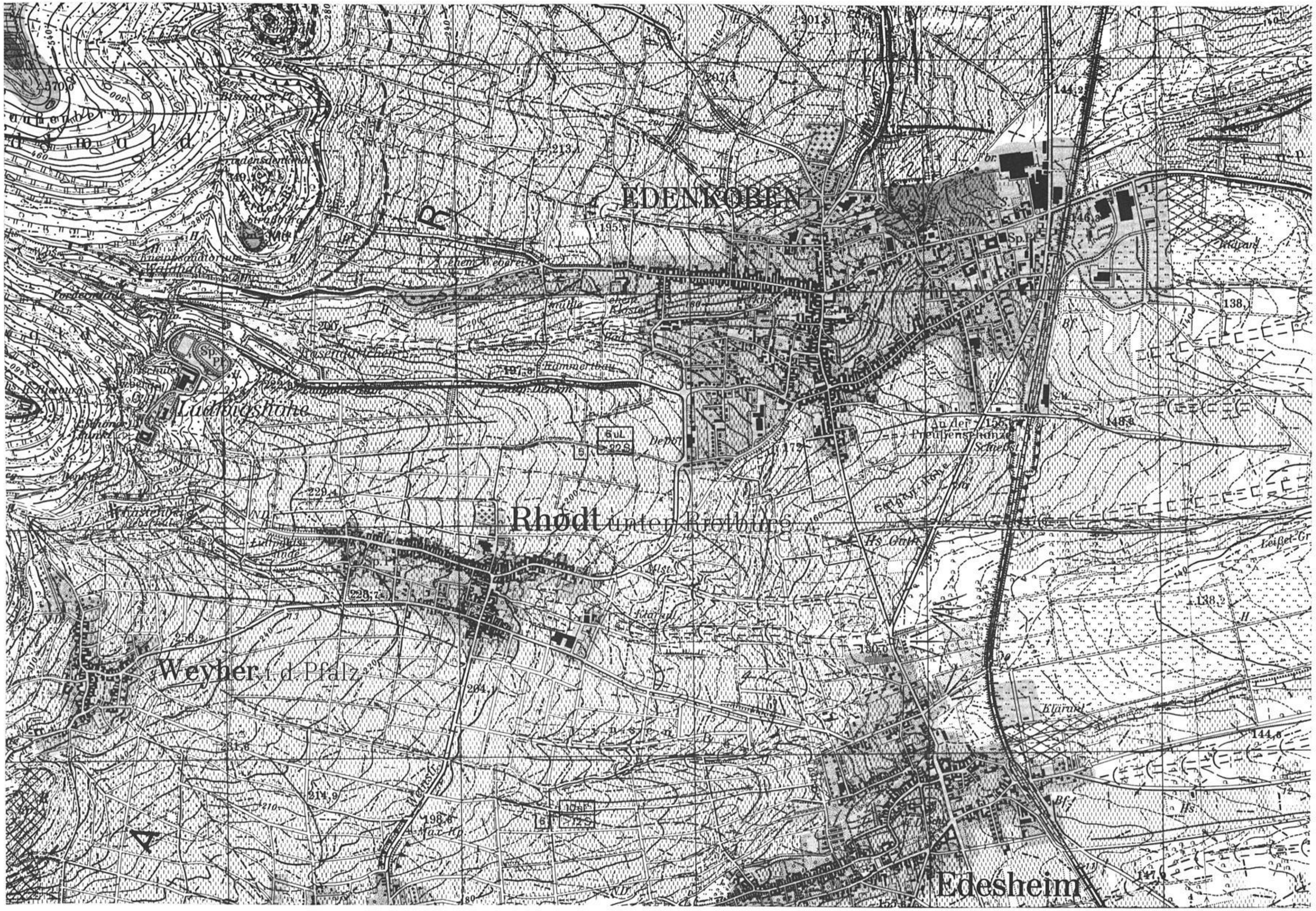

Fig. 7: Western rim of the Rheingraben around Edenkoben.

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Legend of the geomorphological map 1 : 25 000 (GMK 25) – fifth version in the GMK priority program of the Deutsche Forschungsgemeinschaft –

HARTMUT LESER & GERHARD STÄBLEIN

With translations in French by HENRI VOGT,
in Spanish by ELENA MARIA ABRAHAM DE VAZQUEZ and
in Russian by JAROMIR DEMEK.

Abstract: The legend for the detailed geomorphological mapping in large scale, which was agreed upon as the standardized basic concept for the GMK priority program is presented here with translations. The ten year program 1976-1986 was sponsored and financed by the German Research Society (DFG).

On the basis of several discussion papers and preliminary versions the so-called "green legend" was the guideline for field surveys on 35 sheets of the official topographical map of the Federal Republic of Germany. The legend operates on a building-block-principle free to modifications and additions in adaptation to the special regional geomorphological features and has proved applicable to all relief types in Central Europe from the coasts to the Alps.

Kurzfassung: Die Legende zur geomorphologischen Detailkartierung in großem Maßstab, die als einheitliches Grundkonzept für das GMK-Schwerpunktprogramm vereinbart wurde, wird hier mit Übersetzungen dargestellt. Das 10-Jahres-Programm 1976-1986 wurde unterstützt und finanziert durch die Deutsche Forschungsgemeinschaft (DFG).

Auf der Basis mehrerer Diskussionspapiere und Versionen war die sogenannte "Grüne Legende" Richtlinie für Feldkartierungen auf 35 Blättern der amtlichen topographischen Karte der Bundesrepublik Deutschland. Die Legende ist nach einem Baukastenprinzip erstellt, frei für Modifikationen und Ergänzungen für die Anpassung an die speziellen regionalen geomorphologischen Gegebenheiten. Die Legende hat sich von den Küsten bis zu den Alpen für alle Relieftypen in Mitteleuropa als anwendbar erwiesen.

Contents:

0. Introduction

The legend for the geomorphological map 1 : 25 000 (= GMK) of the Federal Republic of Germany was developed in a fundamental discussion and agreement of a working group in which many geomorphologists of Geographical University Institutes took part (BARSCH 1976, LESER 1976, STÄBLEIN 1980). The legend was the standardized basic concept for the GMK priority project. It was a ten year program from 1976-1986, and was sponsored and financed by the German Research Society (= DFG) (BARSCH & LIEDTKE 1980, BARSCH & STÄBLEIN 1982, LIEDTKE 1984, LESER 1985). A first discussion concept was published in 1973 (GÖBEL, LESER & STÄBLEIN 1973). From this first version of the legend the so-called "green legend" as a second varied edition was worked out and edited together with detailed instructions for geomorphological mapping (LESER & STÄBLEIN 1975). In some supplements result's and comments on experience with mapping and conception of the legend are published (STÄBLEIN 1978, BARSCH & LIEDTKE 1980, BARSCH & STÄBLEIN 1982).

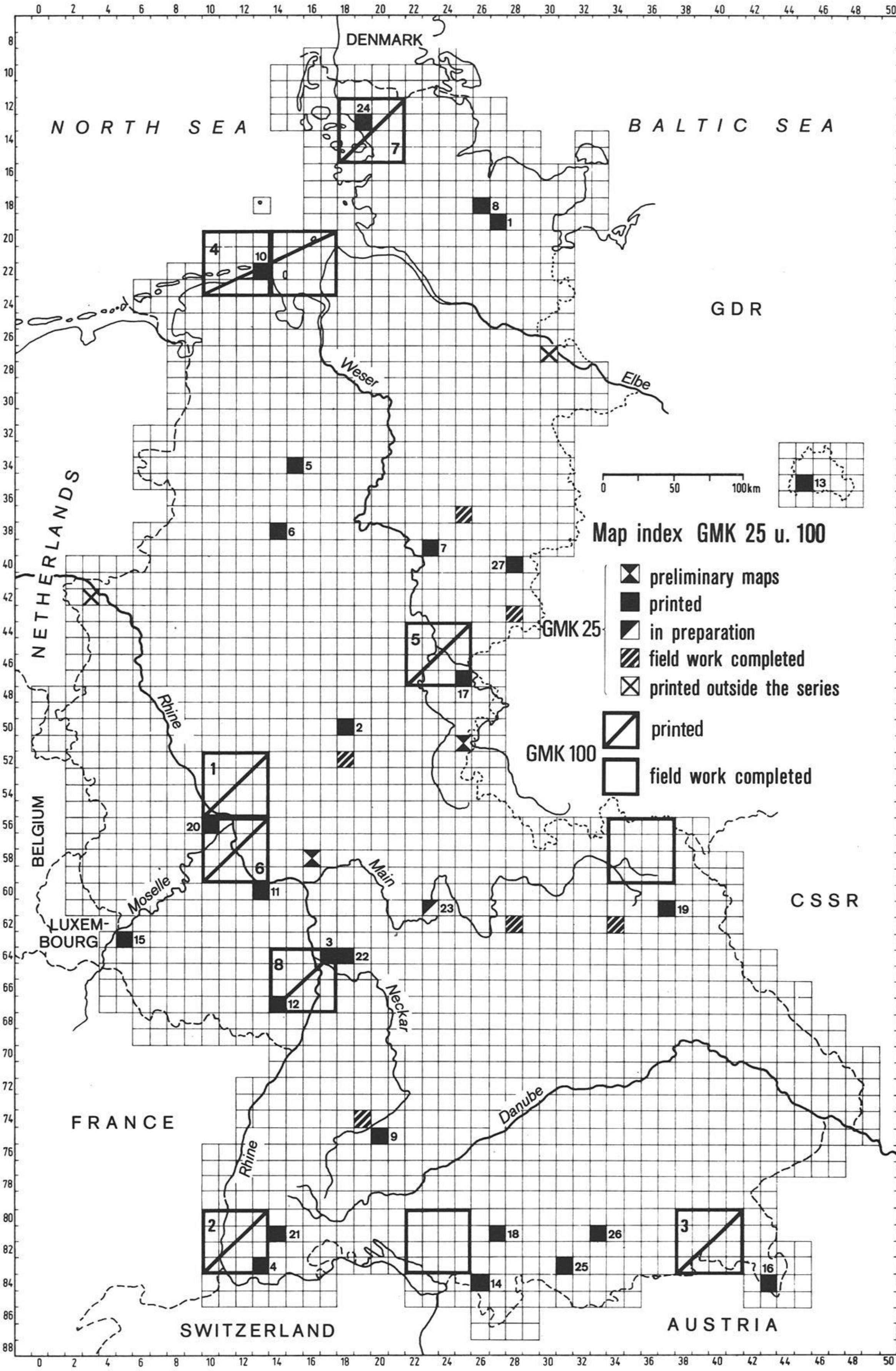
The following fifth version of the general legend includes the alterations and additions, which were necessary in the regional application. The basic conception and the classifications into main classes, categories and rubrics serving also to arrange numbering of particular positions within the main rubrics has partly changed according to additions. Equally the cartographic transformation of the individual sheets implies the numbering of the main rubrics only; the various subpositions are numbered consecutively, i.e. differently for each sheet. Several positions of the legend are only occasional descriptions, used in mapping only for regional or local purposes.

The conception of the legend is based on the "building-block-principle". This allows to outline numerous different complex features composed by individual signatures. The elements of the legend serve to describe in a complex way the analytic detail information concerning the relief, with a maximum of factual and graphical precision and showing a multi-dimensional decompositon. To this end the signatures are selected and combined according to local conditions. The single different elements and properties of habitual, substantial, structural, genetic-dynamic and positional relief description can be identified separately from the map.

The geomorphological conditions (geomorphography and geomorphometry) are described by graphical decomposition of the relief forms into their relief elements with a basic extent of more than 100 m in diameter. Owing to this fact a quantified description of more complex, bigger forms is possible. It is not necessary to represent them by synthetic symbols but only to compose them by analytic signatures. Basic extent (B) means the largest outline diameter of the relief forms, respectively relief elements; regarding the relief forms and relief elements of large longitudinal extension, e.g. terraces or valleys, the width, not the length of the outline is relevant. The basic extent is being measured up to the lateral delimited lines for the axis of curvature.

The "substratum" of the subsoil close to the surface (geomorphostructure) is listed up substantially and genetically as an autochthon and allochthon solid and non-solid rock, normally from 50 cm in exception from 20 cm thickness of layers up to a depth of 100 cm beneath the surface. The extension area (B greater than 100 m) is described in a two-dimensional way. In special cases smaller areas and local field findings can be shown in the map, too. If important for determination and explanation of the forms the deeper underground can be described by similar methods of representation as the surface rock is described, clearly marked as bedrocks in the individual map legend.

The geomorphodynamic and geomorphogenic aspects are represented in the maps by process and structure areas with the limiting fact of B greater than 100 m. These areas correspond to the specific predominant characteristics of the relief due to structural conditions, respectively by effects of process groups. The distinguished process groups are typical complexes of several processes. The individual geomorphologic processes are described only selectively where inherent forms cannot be reproduced due to measure reasons.


DENMARK
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GDR
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FRANCE
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Weser
Elbe
Rhine
Moselle
Main
Neckar
Danube
0
50
100km
Map index GMK 25 u. 100
preliminary maps
printed
in preparation
field work completed
printed outside the series
GMK 25
printed
field work completed
GMK 100

Legend of the geomorphological map 1 : 25 000 (GMK 25)
– 5th version in the GMK priority program of the Deutsche Forschungsgemeinschaft –

The legend which has been binding within the GMK priority program since 1975 is reproduced here, together with recent modifications and additions. It corresponds to the second revised version of an original draft from the planning phase. This was published as the so-called "green legend" together with mapping directions and guidelines.

Legende der Geomorphologischen Karte 1 : 25 000 (GMK 25)
– 5. Fassung im GMK-Schwerpunktprogramm –

Die im Rahmen des GMK-Schwerpunktprogramms seit 1975 verbindliche Legende wird hier einschließlich der neueren Änderungen und Ergänzungen abgedruckt. Sie entspricht der zusammen mit Anleitungen und Richtlinien zum Kartieren als sogenannte "grüne Legende" herausgegebenen 2. veränderten Fassung eines ursprünglichen Entwurfs der Planungsphase.

Légende de la carte géomorphologique 1 : 25 000 (GMK 25)
– 5ème version dans le projet du relèvement géomorphologique détaillé –

La légende du projet du relèvement géomorphologique détaillé, officielle depuis 1975, est imprimée ici avec des modifications et des suppléments nouveaux. Elle correspond à la 2ème version corrigé d'un projet d'origine, dite "légende verte" éditée avec des explications et des instructions concernant le relèvement.

Leyenda del mapa geomorfologico 1 : 25 000 (GMK 25)
– Quinta version del progama esencial –

La leyenda del programa esencial de la GMK que ha estado obligatorio desde 1975 esta reproducido aqui incluso con los nuevos modificaciones y complementos. Corresponde a la segunda version modificado de un borrador original de la fase de planificacion. Esta fue publicada como dicho "leyenda verde", junto con instucciones y directivas para dibujar mapas geomorfologicos.

Легенда для детальных геоморфологических карт I : 25 000 (ГМК)
- 5. версия в рамках проекта детального геоморфологического картирования

Легенда является обязательной в рамках проекта детального геоморфологического картирования начиная из 1975 г. Публикуется вместе с новыми измененями и добавлениями. Отвечает 2. версии на стадию пралнирования проекта. Вторая версия была опубликована вместе с введением и инструкцией для картирования под назвением "зеленая легенда".

GEOMORPHOGRAPHY and GEOMORPHOMETRY
formal relief characteristic

1 **Neigungen** | **Slope angles** | **Pentes** | **Pendientes** | **Крутизна склонов**

Flachland lowland	Mittelgebirge mountains of moderate relief	Hochgebirge alpine relief
0°- 0,5°	0°- 0,5°	0°- 2°
>0,5°- 2°	>0,5°- 2°	>2°- 15°
>2°- 4°	>2°- 7°	>15°- 25°
>4°- 7°	>7°- 11°	>25°- 35°
>7°- 11°	>11°- 15°	>35°- 45°
>11°- 15°	>15°- 35°	>45°- 60°
>15°	>35°	>60°
60°- 90° (B kleiner 100 m; vgl. 4.7)		

Gebiet mit kleinräumig wechselnden Neigungen | area with slope angles varying over small distances | région à pentes variables sur de faibles distances | ârea con inclinación variable en cortas distancias | территория с уклонами склонов менящимися на небольших расстояниях

2 **Wölbungen von Hängen und Rücken** | **Axes of curved slope and crest segments** | **Courbures de versants et intefluves** | **Líneas de curvatura de laderas y crestas** | **Форма склонов и водораздельных поверхностей**

Deutsch	English	Français	Español	Русский
Wölbungslinie	axis of curved relief segment	axe de courbure	eje del segmento curvo	ось кривизны
Wölbungsradius	radius of curvature	rayon de courbure	ratio de curvatura	радиус кривизны
konvex 6 – < 300 m	convex 6 – < 300 m	convexe 6 – < 300 m	convexa 6 – < 300 m	выпуклая 6 – < 300 m
300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m
konkav 6 – < 300 m	concave 6 – < 300 m	concave 6 – < 300 m	cõncava 6 – < 300 m	вогнутая 6 – < 300 m
300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m
Scheitellinie	crest line	ligne de crête	línea de cresta	линия водораздельного гребня

3 **Wölbungen von Kuppen und Kesseln** | **Curvature of hillocks and depressions** | **Courbures de buttes et depressions** | **Curvatura de elevaciones y depresiones** | **Форма куполов и впадин**

Deutsch	English	Français	Español	Русский
Wölbungsradius	radius of curvature	rayon de courbure	ratio de curvatura	радиус кривизны
konvex < 300 m	convex < 300 m	convexe < 300 m	convexa < 300 m	выпуклая < 300 m
300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m
konkav < 300 m	concave < 300 m	concave < 300 m	cõncava < 300 m	вогнутая < 300 m
300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m	300 – 600 m

No.	Symbol	Deutsch	English	Français	Español	Русский
4		**Stufen und Kanten**	**Steps and breaks of slope**	**Abrupts et paliers**	**Escalones y rupturas de pendiente**	Уступы и бровки
		Stufenhöhe: H Grundrißbreite: B	height of step: H width of step: B	hauteur: H largeur: B	altura del escalón: H ancho del escalón: B	метров высоты : H метров ширины : B

No.	Symbol	H[m]	B[m]
4.1		0 - 1	1 - 5
4.2		>1 - 5	1 - 5
4.3		>1 - 5	>5 - 10
4.4		>5 - 20	1 - 5
4.5		>5 - 20	>5 - 10
4.6		>5 - 20	>10
4.7		>20	>5 - 10

No.	Symbol	Deutsch	English	Français	Español	Русский
4.8		Stufe oder Kante mit Fußknick	step or break of slope with base break	abrupts avec rupture de pente à la base	pronunciado acodamiento al pie del escalón o borde (knick)	уступ или бровка с перегибом у подножья
4.9		Wandstufe	cliff	segment subvertical	talud rocoso, paredón	клиф
		Leitlinien des Meso- und Makroreliefs	**Characteristic features of meso and macrorelief**	**Caracteres dominants du mesorélief et du microrélief**	**Rasgos característicos del meso y macrorelieve**	Характерные элементы мезо- и микрорельефа
4.10		Landstufe	escarpment	escarpement	escarpe	уступ
4.11		Schichtufe	cuesta scarp	cuesta ou crêt	cuesta o escalón estructural	куэста
4.12		Stufenhang einer Schichtstufe	front slope of a cuesta scarp	front de cuesta ou de crêt	frente de cuesta	уступ куэсты
4.13		Schichtkammgrat	hogback	hog-back	crestón	моноклинальный гребень
4.14		Schichtkammkante	crest of a hogback	front de hog-back	borde de cresta monoclinal	бровка моноклинального гребня
4.15		Stirnhang eines Schichtkammes	front slope of a hogback	crête de hog-back	frente de cresta monoclinal (anaclinal)	фронтальный уступ моноклинального гребня
4.16		Rückhang eines Schichtkammes	back slope of a hogback	revers de hog-back	reverso de cresta monoclinal (cataclinal)	тыловой склон моноклинального гребня
5		**Täler und Tiefenlinien**	**Valleys and small drainageways**	**Vallées et talwegs**	**Valles y vías de drenaje**	Долины и линии стока
		Breite 25 - 100m ----------------	width 25 - 100m ---------------	largeur 25-100 m ----------------	ancho 25-100 m --------------	ширина 25 - 100 м ------------------
5.1	=)=)=)=)	Muldental	saucer-shaped valley	vallée en berceau	valle en forma de cubeta, fondo de cuna	мульдовая долина
5.2	=]=]=]=]	Sohlental	flat-floored valley	vallée à fond plat	valle de fondo plano	пойменная долина
5.3	>=>=>=>	Kerbtal	V-shaped valley	vallée en V	valle en V (entallado)	У - образная долина

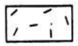
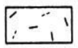
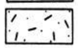
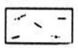
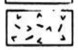
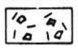
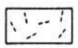
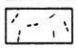
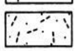
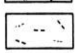
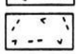
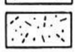
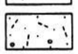
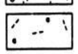
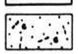
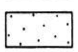
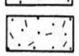
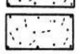
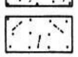
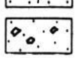
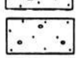
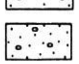
5.4	==)==)	Kerbsohlental	V-shaped valley with flat floor	vallée en V à fond plat	valle en V con fondo plano	У - образная долина с поймой
5.5	==)==)	Muldenkerbtal	saucer-shaped valley with V-shaped bottom	vallée en berceau à fond en V	valle en forma de cubeta con fondo en V	мульдовая долина с оврагом или балькой
5.6	>=>=>=>	asymmetrisches Tal	asymmetrical valley	vallée asymétrique	valle asimétrico	асимметричная долина
		Breite kleiner 25m ------------------	width less than 25m -------------------	largeur inférieure à 25 m -------------------------	menos de 25 m de ancho ----------------------	ширина менше чем 25 м ----------------------
5.7	->--->--->	muldenförmige Tiefenlinie	small saucer-shaped drainageway	vallon en berceau	pequenas líneas de drenaje, en forma de cubeta	делли
5.8	]--]--]	kastenförmige Tiefenlinie	small box-shaped drainageway	vallon à fond plat	pequenas líneas de drenaje, en forma de cajon	балка
5.9	->->->->	kerbförmige Tiefenlinie	small V-shaped drainageway	vallon en V	pequenas líneas de drenaje, en forma de V	овраг
5.10	->->->->	asymmetrische Tiefenlinie	asymmetrical drainageway	vallon asymétrique	pequenas líneas de drenaje asimétricas	асимметричная долина
5.11	->)(<-	Talwasserscheide	in-valley divide	ligne de partage des eaux	divisoria de aguas en valle	долинный водораздел
6		<u>Einzelformen, Kleinformen und Rauheit</u>	<u>Singular landforms, minor landforms and roughness</u>	<u>Formes isolées, formes mineures, rugosite</u>	<u>Formas especiales, menores y de detalle</u>	<u>Отдельные формы, мелькие формы</u>
6.1		Kuppe	knoll / knob	butte	loma	бугор, холм, купол
6.2		Wurt, Warft	terp	butte de schorre	montículo antropogénico en áreas de marea	тэпэ
6.3		Kessel	kettle / cauldron shaped depression	dépression fermée de petite taille	depresión con borde abrupto	впадина, котловина
6.4		Schale, Mulde, Senke	shallow pan	dépression	depresión con bordes suaves	депрессия
6.5		Rinne, abflußlos	trough-shaped depression	talweg sans écoulement	depresión longitudinal	сухая долина
6.6		Doline, Erdfall	doline / sinkhole, earth fall	doline, accumulation corrélative d'éboulement terreux	dolina, dolina de desfondamiento	неглубокие остаточные впадины / ванны / с водой на ваттах
6.7		Karren	lapiès	lapiès	lenar / lapiaz / karren	воронка
6.8		Karrenplatten	karrenfeld	champ de lapiès	campo de lapiaz / lenar	провальная воронка

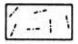
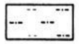
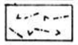
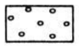
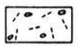
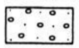
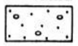
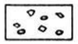
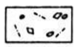
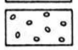
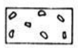
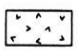
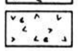
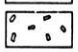
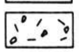
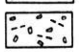
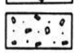
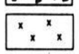
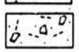
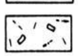
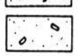
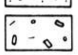
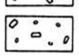
6.9		Karstgasse	"Karstgasse" (cleft-like giant lapiés)	lapiés géants	lapiaz gigante	карры
6.10		Karstschlot, Karstbrunnen	karst funnel, karst well	cheminée karstique, source karstique	pozo, embudo cárstico, cima, sumidero cárstico	карровое поле
6.11		Nische	niche	niche	nicho	богаз
6.12		Sporn	spur	éperon	espolón	карстовый колодец
6.13		Kame	kame	kame	kame	ниша
6.14		Düne	dune	dune	duna / médano	отрог
6.15		Strichdüne	linear dune	dune linéaire	duna longitudinal	камы
6.16		Parabeldüne	parabolic dune	dune parabolique	duna parabólica	дюна
6.17		Primärdüne / Initialdüne	embryonic dune	dune embryonnaire	duna embrionaria / inicial	продольная дюна
6.18		Wall / Erdwall / Damm	earth dam	levée (de terre)	dique de tierra	параболическая дюна
6.19		künstlicher Erdwall	artifical earth dam	levée de terre artificielle	terraplén / dique de tierra artificial	зачаточная дюна, змбриональная дюна
6.20		Rodungswall	earth dam due to clearing	levée de terre liée au défriche-ment	terraplén por deforestación	земляная плотина
6.21		Abgrenzungswall (Euwer, Knick)	enclosure earth dam ("Euwer", "Knick"), hedgerow	levée artificielle de limite de champ	terraplén con arbustos, límite entre parcelas / seto vivo	искуственная земляная плотина
6.22		Ackerberg, Altweg	"Ackerberg", "Altweg"	ackerberg, ancien chemin surélevé	formas producidas por arado	земляная плотина образованная в связи со сведением леса
6.23		Flachrücken	low ridge	dos de terrain plat	lomada baja	межевые валы полей
6.24		alter Seedeich	old sea dike	anciennne digue de lac	antiguo dique marino	останцовые повышения на распаханных полях
6.25		moderner Seedeich	modern sea dike	digue de lac actuelle	dique marino moderno	плоская гряда
6.26		Deckwerk	revetment	revêtement	defensa al pie de un dique marino	старая береговая дамба
6.27		Längswerk	shore protection	protection de littoral	protección costera	современня береговая дамба
6.28		Flußbegrenzungsmauer	boundary wall	mur de bordure de cours d'eau	muro de contención	облицовка
6.29		Uferdamm	embankment	digue	albardón	набережная, причал
6.30		Flutbarre	flood bar	barre de marée	barra litoral	прирусловая дамба
6.31		Erosionskante des Außengrodens	seaward edge of salt marsh	abrupt d'érosion de prés-salés	borde de erosión de marjal marino	береговой вал приливного канала стока
6.32		Erosionsrille am Rand des Außengrodens	marginal erosion rill in salt marsh	ravine d'érosion à la bordure des prés-salés	surcos de erosión en marjal marino	паводковая дамба
6.33		Gesims	ledge	replat rocheux local	cornisa	эрозионная бровка соленого марша

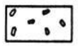
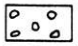
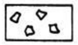
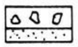
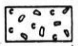
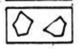
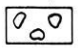
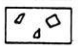
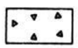
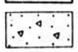
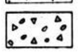
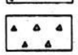
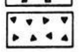
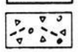
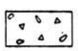
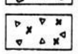
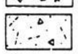
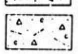
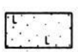
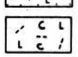
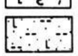
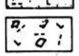
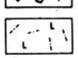
No.	Symbol	Deutsch	English	Français	Español	Русский
6.34		Grat	ridge / crest	crête	cresta / arista / filo	краевая промоина соленого марша
6.35		Schwemmfächer	alluvial fan	cône alluvial aplati	abanico aluvial	выступ, карниз
6.36		Schwemmkegel	alluvial cone	cône alluvial	cono aluvial	гребень
6.37		subaquatischer Schwemm-fächer	subaquatic alluvial fan	cône alluvial sous-aquatique	abanico aluvial subacuático	конус выноса плоский
6.38		Spalten	crevices	crevasses	grietas / hendiduras / fisures	трещина
6.39		Hohlweg	sunken road	chemin creux	camino hondo / desfiladero / canada	дорога в ложбине
6.40		Hohlwegsystem	system of sunken roads	système de chemins creux	sistema de huellas, caminos hondos	система дорог в ложбинах
6.41		Blockansammlungen	accumulation of boulders	accumulation de blocs	acumulación de bloques	курум
6.42		Lesesteinhaufen	heap of stones	pierriers	amontonamientos, pilas de piedras	ракушечные банки
6.43		Deltakomplex	deltaic complex	complexe deltaique	complejo deltaico	дельтовый комплекс
		Kleinformenbereiche	**Areas of minor landforms**	**Aires caracterisées par des formes mineures**	**Areas de formas menores**	**Ареалы мелких форм**
6.44		Kuppenfeld	hummocky terrain	champ de buttes	área con montículos	бугристая поверхность
6.45		Kesselfeld	pitted area	champ de petites dépressions fermées	área poceada, con depresiones	мелкокотловинная поверность, западинная поверхность
6.46		Kuppen- und Kesselfeld	hillocky and pitted area	association de buttes et de petites dépressions fermées	área con montículos y depresiones	бугристо-котловинная поверхность, бугристо-западинная поверхность
6.47		Strichdünenfeld	linear-dune field	champ de dunes linéaires	campo de dunas longitudinales	пески грядовые
6.48		Parabeldünenfeld	parabolic-dune field	champ de dunes paraboliques	campo de dunas parabólicas	поле параболических дюн
6.49		terrassiertes Gelände für Wein- und Ackerbau	terraced vineyards and arable land	terrassettes de culture	terreno aterrazado para vinedo y cultivos	террасированная поверхность под виноградник и распашку
		Rauheit der flächenhaften Reliefelemente	**Roughness of areal relief elements**	**Rugosite des éléments areaux du rélief**	**Microformas en superficies planas**	**Расчленение пологих поверхностей**
6.50		rillig	furrowed	terrain ridé	acanalado, con surcos	бороздчатая
6.51		wellig	undulating	terrain ondulé	ondulado	волнистая
6.52		höckerig, kuppig	hummocky / hillocky	terrain caractérisé par des buttes	mamelonado, corcovado	бугристая
6.53		kesselig	pitted	terrain caractérisé par de petites dépressions fermées	cribado / con muchas depresiones pequenas	западинная

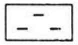
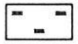
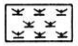
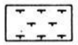
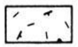
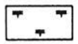
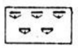
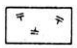
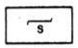
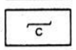
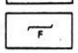
6.54		stufig	stepped	terrain à abrupts	escalonado	ступенчатая
6.55		Wölbäcker	ridged fields	champs bombés	campos abovedados (por arado)	грядовая
6.56		Oberflächenrauheit durch Blockstreu	surface roughness due to scattered boulders	rugosité superficielle due à un semis de blocs	superficie escabrosa por bloques	с расбросанными валунами
6.57		Megarippeln im Watt	mega ripples on tidal flats	mégarides de veys	grandes marcas, rizaduras de marea	мегарябь, крупная рябь на приливано-отливной отмели
7		Formen und Prozeßspuren	Forms and traces of processes	Formes et traces de processus	Formas y evidencias de procesos	Формы и следы процессов
7.1		Würgeboden	cryoturbation	cryoturbation	suelo crioturbado	криотурбация
7.2		Frostmusterboden	patterned ground	sol polygonal	suelo estructurado	структурный грунт
7.3		Eiskeil	ice wedge	coin de glace	cuna de hielo	ледяной клин
7.4		Sandkeilpolygon	sand-wedge polygon	polygone de coins de glace	polígono de cunas de arena	полигоны песчанных клиньев
7.5		Frostriß / Frostspalte	frost crack	fente de gel	grieta, fisura por congelamiento	морозобойная трещина
7.6		glazigene Stauchung	glacial push	moraine de poussée	marcas de compresion glaciar	ледниковый напор
7.8		Windkanter	ventifact	dreikanter	ventifacto	ветрогранник
7.9		Windkanterstreu	scattered ventifacts	semis de dreikanter	ventifactos dispersos	разбросанные ветрогранники
7.10		Findling	erratic boulder	bloc erratique	bloque errático	эрратический валун
7.11		Blockstreu / Findlinge	scattered boulders / erratic boulders	semis de blocs erratiques	cubierta discontinua de bloques erráticos	разбросанные валуны, разбросанные эрратические валуны
7.12		erratische Streu	scattered erratics	semis de cailloutis	bloques erráticos dispersos	разбросанные эрратические валуны
7.13		Augensteinvorkommen	"Augenstein" pebble deposits	dépôt local de galets	depósito de rodados (Augenstein)	
7.14		Karstschlotte	karst chimney	puits karstique	chimenea cárstica	труба / карстовая
7.15		Vegetationshorste	vegetation hummocks	hummocks	vegetación en montículos	растительный бугор
7.16		Vegetationsringe	vegetation rings		vegetación en círculos, en anillos	кольца растительные
7.17		Nivationsnische	nivation hollow	niche de nivation	nicho de nivación	нивационная ниша
7.18		Felsburg	tor	tor	tolmo, tor	скалистая вершина, каменные столбы
7.19		Gletscherschliff	glacial striae	strie glaciaire	roca pulimentada	ледниковые шрамы, штрихи

SUBSTRATA AT THE SURFACE AND IN A SHALLOW DEPTH
(GEOMORPHOSTRUCTURE)
substantial relief characteristic

8		Substrate	Material	Substrat	Material del sustrato	Субстрат / литологические данные
		Granulometrische Substratangaben	granulometric characteristics	granulométrie	Características granulométricas	гранулометрический состав
8.1		Ton	clay	argile	arcilla	глина
8.1.1		schluffiger Ton	silty clay	argile silteuse	arcilla limosa	алевритовая глина, алевритистая глина
8.1.2		sandiger Ton	sandy clay	argile sableuse	arcilla arenosa	песчанистая глина
8.1.3		lehmiger Ton	loamy clay	argile limoneuse	arcilla legamosa	суглинистая глина
8.1.4		grusiger Ton	gritty clay	argile à sable grossier	arcilla con arenilla	дресвянистая глина
8.1.5		steiniger Ton	stony clay	argile pierreuse	arcilla con clastos	щебнистая глина
8.2		Schluff	silt	silts	limo *	алеврит, силт
8.2.1		toniger Schluff	clayey silt	silt argileux	limo arcilloso	глинистый алеврит
8.2.2		sandiger Schluff	sandy silt	silt sableux	limo arenoso	песчанистый алеврит
8.2.3		lehmiger Schluff	loamy silt	silt limoneux	limo legamoso	суглинистый алеврит
8.2.4		grusiger Schluff	gritty silt	silt à sable grossier	limo con arenilla	дресвянистый алеврит
8.2.5		sandig-toniger Schluff	sandy clayey silt	silt sablo-argileux	limo arcillo-arenoso	песчано-суглинистый алеврит
8.2.6		kiesig sandiger Schluff	gravelly sandy silt	silt caillouteux et sableux	limo arenoso con gravas	алеврит с гравием и песком
8.2.7		kalkhaltiger Schluff	calcareous silt	silt carbonaté	limo calcáreo	известковистый алеврит
8.2.8		kalkhaltig-sandiger Schluff	calcareous sandy silt	silt sableux carbonaté	limo calcáreo arenoso	**известковый песчанистый алеврит**
8.3		Sand	sand	sable	arena	песок
8.3.1		toniger Sand	clayey sand	sable argileux	arena arcillosa	глинистый песок
8.3.2		schluffiger Sand	silty sand	sable silteux	arena limosa	алевритистый песок
8.3.3		lehmiger Sand	loamy sand	sable limoneux	arena legamosa	супесь
8.3.4		steiniger Sand	stony sand	sable pierreux	arena con clastos	щебнистый песок
8.3.5		kiesiger Sand	gravelly sand	sable à cailloutis	arena con gravas	песок с гравием
8.3.6		Sand mit Geröll	sand with gravels	sable à galets	arena con rodados	песок с галькой

8.4		Lehm	loam	limons	légamo ("suelo franco")	суглинок
8.4.1		toniger Lehm	clayey loam	limon argileux	légamo arcilloso	глинистый суглинок
8.4.2		schluffiger Lehm	silty loam	limon silteux	légamo limoso	пылеватый суглинок
8.4.3		sandiger Lehm	sandy loam	limon sableux	légamo arenoso	песчанистый суглинок
8.4.4		grusiger Lehm	gritty loam	limon à sable grossier	légamo con arenilla	десвянистый суглинок
8.4.5		steiniger Lehm	stony loam	limon pierreux	légamo con clastos	щебыистый суглинок
8.4.6		kiesig-sandiger Lehm	gravelly sandy loam	limon à cailloutis	légamo arenoso con gravas	с песчано-суглинистым матриксом
8.5		Kies, Geröll	gravels	cailloutis, galets	gravas, rodados	гравий, галечник
8.5.1		schluffiger Kies	silty gravels	cailloutis silteux	gravas limosas	илистый гравий
8.5.2		sandiger Kies	sandy gravels	cailloutis sableux	gravas arenosas	песчанистый гравий
8.5.3		sandig-kiesig	sandy to gravelly	sablo-caillouteux	con arena y gravas	песчано-гравийный
8.5.4		steinig-kiesig	stony to gravelly	pierres et cailloutis	con gravas y clastos	щебнисто-гравийный
8.5.5		verlehmte Schotter	loamy gravels	galets fortement altérés	gravas con légamo de meteorización	суглинисто-гравийный
8.5.6		mit Geröll	with gravels	à galets	con rodados	с галечником, с галькой
8.5.7		blockiges Geröll	bouldery gravels	galets grossiers	rodados gruesos	
8.6		Grus	grit	sable grossier	arenilla	детрит
8.6.1		Kalkgrus	limestone grit	débris calcaires de sable grossier	arenilla de caliza	детрит известняков
8.7		Schutt	debris	dépôts de pente	detritos / escombros	обломочные склоновые отложения, дебрис
8.7.1		toniger Schutt	clayey debris	dépôt de pente argileux	detritos con arcilla	глинистый дебрис
8.7.2		schluffiger Schutt	silty debris	dépôt de pente silteux	detritos con limo	илистый дебрис
8.7.3		sandiger Schutt	sandy debris	dépôt de pente sableux	detritos con arena	песчанистый дебрис
8.7.4		steinig	stony	caillouteux	pedregoso	щебнистый дебрис
8.7.5		sandig-schluffiger Schutt	sandy silty debris	dépôt de pente sablo-silteux	detritos con arena y limo	песчанисто-илистый дебрис
8.7.6		schluffig-sandiger Schutt	silty sandy debris	dépôt de pente silto-sableux	detritos con lima y arena	илисто-песчанистый дебрис
8.7.7		tonig-lehmiger Schutt	clayey loamy debris	dépôt de pente argilo-limoneux	detritos con arcilla y légamo	глинисто-суглинистый дебрнс
8.7.8		sandig-lehmiger Schutt	sandy loamy debris	dépôt de pente sablo-limoneux	detritos con arena y légamo	песчанисто-сыглинистый дебрис
8.7.9		tonig-kiesiger Schutt	clayey gravelly debris	dépôt de pente argilo-caillouteux	detritos con arcilla y gravas	глинисто-галечниковый дебрис
8.7.10		kiesiger Schutt	gravelly debris	dépôt de pente caillouteux	detritos con gravas	галечниковый дебрис

8.7.11		kiesig-blockiger Schutt	gravelly blocky debris	dêpôt de pente caillouteux à blocs	detritos con gravas y bloques	галечниково-валунный дебрис
8.7.12		blockiger Schutt	blocky debris	dêpôt de pente à blocs	detritos con bloques	валунный дебрис
8.7.13		mit rundlichem Blockschutt	with rounded blocky debris	dêpôt de pente à blocs êmoussês	con bloques redondeados	с ократанными валунами
8.7.14		mit kantigem Schutt	with angular debris	dêpôt de pente à êlêments argileux	con clastos angulosos	с угловатыми обломками
8.7.15		mit plattigem Schutt	with slaty debris	dêpôt de pente à êlêments aplatis	con clastos en forma de placas, lajas	с плоскими обломками
8.7.16		Schuttdecken	waste cover	couverture de dêpôt de pente	manto de detritos	щобневый покров
8.7.17		Kalkschutt	limestone debris	dêpôt de pente calcaire	detritos de caliza	известняковый дебрис
8.7.18		Grobblöcke	boulders	gros blocs	grandes bloques	валуны
8.7.19		Blöcke, gerundet	rounded blocks	blocs, êmoussês	bloques redondeados	окатанные глыбы
8.7.20		Blöcke, kantig	angular blocks	blocs, anguleux	bloques angulosos	угловатые глыбы
		<u>Genetische Substratangaben</u>	<u>genetic types of material</u>	<u>genêse de substrat</u>	<u>Datos genêticos del material</u>	<u>Генетический тип субстрата</u>
8.8		<u>Moräne</u>	<u>moraine</u>	<u>moraine</u>	<u>morena</u>	<u>морена</u>
8.8.1		sandige Moräne	sandy moraine	moraine sableuse	material morênico arenoso	песчанистая морена
8.8.2		kiesige Moräne	gravelly moraine	moraine caillouteuse	material morênico con gravas	галечниковая морена
8.8.3		Grundmoräne	ground moraine	moraine de fond	morena de fondo	донная, основная морена
8.8.4		Endmoräne	terminal moraine	moraine terminale	morena terminal	конечная морена
8.8.5		Endmoränenvertreter	terminal moraine or equivalent ice marginal forms and deposits	êquivalent de moraine terminale	formas y depôsitos equivalentes a morenas terminales	заместител конечной морены или краевых форм и отложений
8.8.6		blockreiches Moränenmaterial	bouldery till	matêriel morainique à blocs abondants	material morênico con bloques	валунная моренная глина
8.8.7		steiniges Moränenmaterial	stony till	matêriel morainique pierreux	material morênico con clastos	каменистая моренная глина
8.8.8		Geschiebelehm	boulder clay	matêriel de moraine de fond d' inlandsis, limoneux	lôgamo con bloques de origen glacial	валунная глина
8.8.9		Geschiebemergel	boulder marl	matêriel de moraine de fond d' inlandsis, marneux	margas con bloques de origen glacial	валунный мергель
8.9		<u>Löß</u>	<u>loess</u>	<u>loess</u>	<u>loes</u>	<u>лесс</u>
8.9.1		Sandlöß	sandy loess	loess sableux	loes arenoso	печанистый лесс
8.9.2		Löß, kalkhaltiger Schluff	loess, calcareous silt	loess, silt carbonatê	loes, limo calcâreo	лесс, известковистый алеврит
8.9.3		Schwemmlöß	deluvial loess	loess flottê	loes aluvial	переотложенный лесс, склоновый лесс
8.9.4		Kolluviallöß	colluvial loess	loess colluvial	loes coluvial	коллювиальный лесс
8.9.5		Lößlehm	loess loam	lehm	lôgamo loêsico	лессовидный суглинок

8.10		Organische Substrate	organic deposits	substrats organiques	Depósitos orgánicos	органические отложения
8.10.1		Anmmoor	boggy ground	terrain à tourbières	anmoor	болотная поверхность
8.10.2		Niedermoor	low fen	tourbière basse	turbera baja, cenagal, pantano	низинное болото
8.10.3		Hochmoor	raised bog	tourbière de versant	turbera alta, turbera umbrófila	верховое болото
8.10.4		Deckenmoor	blanket bog	tourbière couvrante	"Deckenmoor"	покровное болото
8.10.5		Torf	peat	tourbe	turba	торф
8.10.6		toniger Torf	clayey peat	tourbe argileuse	turba arcillosa	глинистый торф
8.10.7		Niedermoortorf	peat (low fen, swamp)	tourbe de tourbière basse	turba de cenagal o pantano	торф низинного болота
8.10.8		Hochmoortorf	peat (raised bog)	tourbe de tourbière de versant	turba umbrófila	торф верхового болота
8.10.9		Moostorf Bruchwald-Seggentorf	moss peat swamp forest and sedge peat	tourbe à mousses tourbe de forêt marécageuse	turba de briofitas turba de pantanos boscosos y de Carex	моховый торф осоковый торф
8.10.11		Sandmudde	sandy mud	boue sableuse	sedimento lacustre con arenas	песчанистый ил
8.10.12		Kalklutit	calcareous mud	lutite calcaire	sedimento lacustre con calcáreo	известковистый торф
8.10.13		Faulschlamm	sapropel	sapropel	sapropel	сапропель
8.11		Genetische Substrate	genetic materials	génèse des substrats	Clasificación genética del material	Происхождение / генезис / субстрата
			In der Karte durch Körnungsangaben in der Kombination mit Prozeßbereichen abzuleiten. To deduce from the map by a combination of grain size and process information.			
8.11.1		Solifluktionsschutt	soliflual debris / solifluction waste	dépôt de gélifluxion	detritos solifluidales	солифлюкционный дебрис
8.11.2		Hangschutt	waste cover on slopes	dépôt de versant	derrubio	рыхлый обломочный материал на склонах
8.11.3		Fließerdedecke	soliflual mantle	nappe de solifluxion	cubierta de solifluccíon	солифлюкционный покров
8.11.4		Periglazialschutt	periglacial debris	dépôt de versant périglaciaire	detrito periglacial	перигляциальный дебрис
8.11.5.		mit eingeregelten Blöcken, periglaziale Fließerde	blocky, periglacial soliflual mantle	à blocs orientés, nappe de gélifluxion	cubierta solifluidal con bloques orientados	солифлюкционных покров с крупными обломками
8.11.6		Verwitterungsdecke	weathering mantle	manteau de produits de météorisation	manto, cubierta detrítica	кора выветривания
8.11.7		Kolluvium	colluvium	colluvions	depósito coluvial	коллювий
8.11.8		Hangfußablagerung	accumulation of slope foot deposits	dépôts de pied de versant	coluvión, derrubio de faldeo	отложения у подножья склонов
8.11.9		Bergrutschmassen	landslide debris	dépôts corrélatifs de glissements de terrain	depósito de deslizamiento	оползневые отложения

8.11.10	Bergsturzblöcke	rockfall boulders	blocs d'éboulement	bloques de derrumbe	глыбы камнепада
8.11.11	Auensediment	flood plain deposits	dépôts d'inondation	depósitos de planicie aluvial	пойменные отложения
8.11.12	Talsande	valley sands	dépôt sableux de fond de vallée	depósitos arenosos en fondos de valle	долинные пески
8.11.13	äolische Sande	aeolian sands	sable éolien	arena eólica	эоловые пески
8.11.14	Sand, periglazifluvial	fluvioperiglacial sand	sable fluviatile périglaciaire	arena periglacifluvial	речные пески перигляциальной области
8.11.15	kiesiger Sand, meist ablual	gravelly sand, largely reworked	sable caillouteux, généralement remanié par action périglaciaire	arena con gravas, con transporte periglacial	гравелистый песок, переотложенный
8.11.16	kiesiger Sand, gestaucht	gravelly sand, ice-pushed	sable caillouteux affecté par la glacitectonique	arena con gravas perturbada por empuje glaciario	гравелистый песок, перемещенный напором ледника
8.11.17	Sand, glazifluvial	glaciofluvial sand	sable glacio-fluvial	arena glacifluvial	глювиогляациальный песок
8.11.18	Nachschüttsand	outwash sediment	dépôt de fonte de glace (outwash sediment)	arena glacifluvial	зандровые отложения, флювиогляциальные отложения
8.11.19	Sanderablagerung	outwash plain deposits	dépôts de sander	depósitos de planicie fluvioglacial / Sander	отложения зандровой равнины
8.11.20	Kameablagerung	kame deposits	dépôt de kame	depósitos de kame	отложения камов
8.11.21	Eisrandablagerung	ice marginal deposits	dépôt juxtaglaciaire	depósitos de margen glaciar	краевые отложения
8.11.22	Geschiebe	boulders	galets et blocs fluviatiles	errático	ледниковый валун, эрратический валун
8.11.23	Schmelzwasserablagerung	melt water deposits	dépôt de fonte de glace	depósito glacifluvial	отложения талых вод
8.11.24	Seeton	lacustrine clay	argile lacustre	arcilla lacustre	озерная глина
8.11.25	mariner Schlick	marine mud	vase marine	fango marino	морской ил
8.11.26	Roh-Seemarsch	salt marsh	marais littoral salé	marjal joven	новейший соленый марш
8.11.27	Seemarsch	salt marsh	marais littoral	marjal marino	соленый марш
8.11.28	Brack-Seemarsch	brackish salt marsh	marais littoral saumâtre	marjal fluvio-marino	солоноватый марш
8.11.29	Kalksteinbraunlehm	terra fusca	sol brun sur calcaire (terra fusca)	terra fusca	бурая известковистая глина, терра фуска
8.11.30	anthropogene Sedimente: Müll, Bauschutt	anthropogenic sediments: rubbish, dump of building	dépôts anthropiques: ordures, débris de constructions	sedimentos antropogénicos: desperdicios, escombros	антропогенные отложения, строительный мусор
8.11.31	Bauschutt	dump of building / construction debris	débris de constructions	escombros antropogénicos	строительный мусор
8.11.32	Aufschüttung	dump upbuilding	accumulation	terraplén, depósito antrópico	строительный мусор
8.11.33	Trümmerschutt	building rubble	dépôt de ruines	escombros de edificios	насып, навезенная глина
8.11.34	anthropogen bedingte Akkumulation	anthropogenic accumulation	dépôt anthropique	acumulación antropogénica	антропогенная аккумуляция

8.12		Ergänzende Substratangaben	supplementary information on material	compléments sur les substrats	Informaciones complementarias sobre el material	Дополнительные данные об материале
8.12.1	c	kalkhaltig	calcareous	carbonaté	calcáreo / contenido de calcio	известковый
8.12.2	Wk	Wiesenkalk	meadow chalk	craie de prairie	toba caliza / caliza de los prados	луговый мел
8.12.3		Quellkalk	freshwater limestone	travertin	tufa, toba caliza / travertino	персноводный известняк, травертин
8.12.4	S	salzhaltig	saline	salin	salino	соляной
9		Lagerung des Lockermaterials	bedding characteristics of unconsolidated materials	structure du matériel meuble	Disposición del material suelto (no consolidado)	Характеристика слоистости неконсолидированного материала
9.1		geschichtet	bedded	lité	estratificado	слоистый
9.2		eingeregelt in Transportrichtung	oriented in direction of transport	orienté dans là direction du courant	orientado en la dirección del transporte	ориентированный в направлении транспорта
9.3		in situ	in situ	in situ	in situ	ин ситу
9.4		Schüttungsrichtung	direction of transport	direction de transport	dirección del transporte	направление транспорта
9.5		homogen (ungeschichtet und nicht eingeregelt)	homogeneous	homogène (non lité et sans orientation dominante)	homogêneo (no estratificado y no orientado)	гомогенный (не слоистый и не ориентированный)
10		Schichtigkeit des Substrates	layering of subsurface material	litage du substrat	Estratificación del material del sustrato	Расслоенность подповерхностного субстрата
10.1		Auflagerung (Deckschicht) z.B. Anmoor auf holozänen Sanden	overlying material (cover) e.g. boggy ground on Holocene sands	dépôt de couvertures, p.ex. tourbe sur sable holocène	material de cobertura (cubierta) ej. Anmoor sobre arenas holocénicas	покровный слой, например болото на голоценных песках
10.2		Unterlagerung z.B. schluffiger Geschiebelehm unter Sand: Grundmoräne unter Nachschüttsanden	underlying material e.g. silty boulder clay under sands, ground moraine under outwash sediments	dépôt couvert, p.ex. limon morainique à blocs sous matériel sableux: moraine de fond sous sable de fonte de glace	material subyacente ej. légamo limoso con erráticos bajo arena, morena de fondo bajo arenas glacifluviales posteriores	подстилающий материал, например алевритовая моренная глина перекрытая песком, основная морена перекрытая зандровыми отложениями
10.3	uLX sLG	Schichtlagerung in Einzelprofilen	stratification in sections	litage en coupes isolées	perfiles con la estratificación	расслоенность в разрезах
10.4	~18	Schichtmächtigkeit in dm	thickness of strata in dm		espesor de los estratos en dm	мощность в дециметрах
10.5	5US 2X 3G	Wechsellagerung in Einzelprofilen	alternate bedding in sections	litage alterné en coupes isolées	perfiles de estratos alternantes	перемехающаяся слоистость в разрезах

11	Oberflächengestein	surface rocks	roche affleurante	rocas superficiales	Породы на поверхности
11.1	Sandstein	sandstone	grès	arenisca	песчаник
11.2	Quarzit	quartzite	quartzite	cuarcita	кварцит
11.3	Quarz	quartz	quartz	cuarzo	кварц
11.4	Kalkstein	limestone	calcaire	caliza	извастняк
11.5	Dolomit	dolomite	dolomite	dolomita	доломит
11.6	Kalksandstein	calcareous sandstone	grès calcaire	arenisca calcărea	извастновый песчаник
11.7	Mergel	marl	marne	marga	мергель
11.8	Mergelstein	marlstone	marne consolidēe	marga endurecida	мергель / глинистый известняк
11.9	Tonmergel	clay marl	marne d'argile	marga arcillosa	глинистый мергель
11.10	Schieferstein (=Tonstein)	shale	ardoise	arcilla endurecida / arcilla pizarrosa	глинистый сланец
11.11	Schluffstein	siltstone	siltstone	limo endurecido / limolita	алевролит
11.12	Metamorphit	metamorphic rocks	roche mētamorphique	metamorfita	метаморфическая горная порода
11.13	Effusit / Ergußgestein	effusive, extrusive rocks	roche volcanique	efusita / roca efusiva	экструзивная / эффузивная / горная порода
11.14	Plutonit / Tiefengestein	plutonic, intrusive rocks	roche intrusive	plutonita / roca intrusiva	интрузивная / глубинная / горная порода
11.15	Brekzie	breccia	brĕche	brecha	брекчия
11.16	Konglomerat	conglomerate	conglomĕrat	conglomerado	конгломерат
11.17	Tonschiefer	slate	schiste	pizarra arcillosa	метаморфический сланец, аспидный сланец, кровельный сланец
11.18	Gips	gypsum	gypse	yeso	гипс
11.19	Kalktuff	calcareous tufa	tuf calcaire	tufa, toba caliza	известковый туф
11.20	Streichen und Fallen der Gesteinsschichten, z.B. Fallen 23° nach NE	strike and dip of strata e.g. dip 23° to NE	orientation et pendage, p.ex. pendage de 23 vers le N.E.	orientaciŏn y buzamiento de los estratos. Ej. buzamiento 23 hacia el NE	простирание и угол наклона / падение / слоев, например падение 23^{0} на СВ
	söhlig	horizontal	horizontal	casi horizontal	горизонтальное залегание
	flach bis mäßig steil (1-30°)	slihtly to moderately inclined (1-30°)	pendage faible ă modērē (1-30)	leve a moderadamente inclinado (1-30)	пологое - среднее (I - 30^{0})
	steil (30-60°)	steeply inclined (30-60°)	pendage fort (30-60°)	muy inclinado (30-60°)	крутое (30 - 60^{0})
	sehr steil (60-89°)	very steeply inclined (60-89°)	pendage trĕs fort (60-89°)	abruptamente inclinado (60-89°)	очень крутое (60 - 89^{0})
	saiger	vertical	vertical	vertical	вертикальное
	überkippt	overtilted	renversĕ	volcado / acostado	опрокинутое

GEOMORPHODYNAMICS and GEOMORPHOGENESIS
genetic-dynamic relief characteristic

12		Geomorphologische Prozesse	geomorphic processes	processus géomorphologiques	Procesos geomorfológicos	Геоморфологические процессы
12.1		flächenhafte Abspülung	sheet wash	ruissellement aréal	erosión laminar, mantiforme	плоскостный смыв
12.2		Disposition für flächenhafte Abspülung	tendency to sheet wash	tendance au ruissellement aréal	tendencia, predisposición para la erosión laminar	условия для плоскостного смыва
12.3		Rinnenspülung	rill erosion	ravines	erosión en surcos	промоинная эрозия,струйчатая эрозия
12.4		Hangerosion	erosion on slope	incision sur versant	erosión en ladera	эрозия на склоне
12.5		Steinschlag	rockfall	éboulis	derrumbe	камнепад
12.6		Rutschung, allgemein	landslide, general	glissement de terrain en général	deslizamiento, general	оползни, общ
12.7		Disposition für Rutschung	tendency to sliding	tendance aux glissements de terrain	tendencia al deslizamiento	условия для оползневых процессов
12.8		Rutschung im Block	slumping	glissement en bloc	deslizamiento en masa	обвал
12.9		Rutschung in Schollen	landslides by slippage	glissement par paquets	deslizamiento en gleba	глыбовые оползни
12.10		Bildung von Abrißspalten	formation of break-off fissures	formation de pentes d'arrachement	formación de fisuras de desprendimiento	образование трещин отделения
12.11		Bodenkriechen	soil creep	reptation	reptación	сползание почвы, крип
12.12		Solifluktion	solifluction	gélifluxion	solifluccíon, gelisolifluccíon	солифлюкция
12.13		Erdfließen	earthflow	solifluxion	reptación, solifluccíon	оползень, солифлюкция
12.14		Durchtränkungsfließen	saturation soil creep	solifluxion par saturation	solifluccíon por saturación	оплывание водой перенасыщенного грунта
12.15		Murenbildung	mudflow	coulées boueuses	corriente de barro	сели, селевой поток
12.16		Lawinenbahn	avalanche tracks	couloir d'avalanche	canal de avalanchas	след лавины, лавинный желоб
12.17		Steinschlagrinne	rockfall chutes	couloir d'éboulis	huella de derrumbe	желоб камнепада
12.18		Lösung	solution	dissolution	disolución	растворение
12.19		Kalkausfällung / Sinterbildung	formation of tufas	précipitation de calcaire/travertins	precipitación de calcáreo / formación de tobas calcáreas	образование известкового туфа
12.20		Setzung	settling		hundimiento por compactación	проседание вызванное растворением извести
12.21		Sackung	subsidence	affaissement	hundimiento / subsidencia	проседание вызванное таянием мертвого лда / образование западин
12.22		Toteissackung	pitting	affaissement par fonte de glace morte	hundimiento por hielo muerto / termokarst	боковая эрозия
12.23		Suffosion	piping	suffosion	sufusión	подмыв

12.24		Seitenerosion	lateral erosion	sapement	erosión lateral	вертикальная эрозия
12.25		Unterspülung	undercutting	affouillement	zapamiento, socavamiento	русловая эрозия
12.26		Tiefenerosion	incision / vertical linear erosion	incision linéaire	erosión vertical / profundización	аккумуляция
12.27		Sohlenerosion	channel erosion	incision de fond de chenal	profundización de cauce	абразия
12.28		Akkumulation	accumulation	accumulation	acumulación	места современного подрезания берегов русел
12.29		Abrasion	abrasion	abrasion	abrasión	подмыв и образование ниш
12.30		Arbeitskanten an Fließgewässern	nick point at the edges of channels	berges actives	bordes de erosión actual en cauces	участки распостранения тонкозернистых отложений
12.31		Unterspülung und Kehlenbildung	undercutting and formation of notches	affouillement et formation d' un goulet	socavamiento y formación de acanaladuras	дефлция, выдувание
12.32		Feinsedimentationsbereich	area of fine sediments	domaine de sédimentation fine	área de sedimentación fina	образование мерзлотных бугров
12.33		Deflation	deflation	déflation	deflación	образование коровьих троп
12.34		Bildung von Frostaufbrüchen	formation of frost bulges	formation de loupes de gel	formación de domos pequenos por congelamiento	повреждение дамб образованием коровьих троп
12.35		Bildung von Viehtritten	formation of steps by cattle or sheep	formation de pieds de vaches	formación de huellas de ganado	антропогенное выравнивание
12.36		Deichschaden durch Viehtritte	dike damage by steps of cattle or sheep	digues endommagées par le piétinement du bétail	danos en diques por huellas de ganado	выравнивание распашкой почвы
12.37		anthropogene Planation	man-made planation	planation anthropique	nivelación antropogénica	район антропогенного выравнивания
12.38		planierende Wirkung des Pflügens	planation by ploughing	planation due au labour	nivelación por arado	выравнивание бульдозером
12.39		planierende Wirkung durch flächenhafte anthropogene Eingriffe	areal man-made planation	planation par action anthropique aréale	nivelación antropogénica	
12.40		Einebnung durch Planierraupen	planation by bulldozing	planation par bulldozer	nivelación por motoniveladora	
13		<u>Geomorphologische Prozeß- und Strukturbereiche</u>	<u>areas of geomorphic structures and processes</u>	<u>domaines des processus géomorphologiques et domaines structuraux</u>	<u>Areas de estructuras y procesos geomorfológicos</u>	<u>Районы геоморфологических процессов и структур</u>
13.1	weinrot ruby	<u>tektonisch / magmatisch</u>	<u>tectonic / magmatic</u>	<u>tectonique / magmatique</u>	<u>tectónico / magmático</u>	<u>тектонические / магматические</u>
13.2	blau blue	<u>marin / limnisch</u>	<u>marine / lacustrine</u>	<u>marin / limnique</u>	<u>marino / lacustre</u>	<u>морские / озерные</u>
13.2.1		marin, ständig überfluteter Bereich	marine, subtidal area	marin, domaine subtidal	marino, siempre sumergido por mareas	морские, во время прилива всегда покрытые водой

13.2.2		marin, bei Hochwasser überfluteter Bereich, ohne Vegetation	marine, tidal flat without vegetation	marin, domaine intertidal sous végétation	marino, área cubierta por marea alta, sin vegetación	морские, приливно-отливная отмель без растительного покрова
13.2.3		marin, bei Hochwasser überfluteter Bereich mit Queller-Vegetation	marine, tidal salt marsh with Salicornea	marin, domaine intertidal à salicornes	marino, área cubierta por marea alta, con vegetación de Salicornea	морские, приливно-отливный марш, солянковые поверхности
13.2.4		marin, äolisch überformt; Naßstrand	marine, modified by aeolian processes; foreshore	marin, remaniement éolien; avant-plage	marino, transformado por procesos eólicos; anteplaya, playa húmeda	морские, переработанные эоловыми процессами, нижний пляж; приливно-отливная полоса
13.2.5		marin, Ebbe-Delta im Watt	marine, ebb delta in tidal flat	marin, delta de marée basse en domaine intertidal	marino, delta de reflujo en bajamar	морские, отливная дельта в приливно-отливной отмели
13.2.6		marin, Flut-Delta im Watt	marine, flood delta in tidal flat	marin, delta de marée haute en domaine intertidal	marino, delta de flujo en bajamar	**морские, приливная дельта в приливно-отливной отмели**
13.3	hellgelb / light yellow	<u>äolisch (Sand)</u>	<u>aeolian (sand)</u>	<u>éolien (sable)</u>	<u>eólico (arena)</u>	<u>эоловые (песок)</u>
13.3.1		äolisch (Dünen, Ausblasung, Flugsanddecken)	aeolian (dunes, deflation, cover sands)	éolien (dunes, déflation, manteau de sable éolien)	eólico (dunas, deflación, mantos de arena eólica)	эоловые (дюны, выдувание, покровные пески)
13.3.2		äolisch, marin überformt; Trockenstrand	aeolian, modified by marine processes; backshore	éolien, remaniement marin; (arrière plage)	eólico, transformado por procesos marinos, playa seca	эловые, переработанные морскими процессами; верхний пляж
13.3.3		äolisch, Dünen	aeolian, dunes	éolien, dunes anciennes-récentes	eólico, dunas, médanos	эоловые, дюны
		(jünger-älter)	(younger-older)		(reciente - antiguo)	(современные - ископаемые)
13.4	dunkelgelb / dark yellow	<u>äolisch (Löß)</u>	<u>aeolian (loess)</u>	<u>éolien (loess)</u>	<u>eólico (loes)</u>	<u>эоловые (лесс)</u>
13.5	blaugrün / bluish green	<u>karstisch / subrosiv / korrosiv</u>	<u>karstic / subrosional / corrosive</u>	<u>karstique, corrosion</u>	<u>cárstico / suberosivo / corrosivo</u>	<u>карстовые / коррозионные</u>
13.5.1		silvaner Karst	karst under wood cover	karst sous forêt	procesos cársticos bajo cubierta boscosa	карст покрытый лесом
13.5.2		waldfreier Karst	karst without wood cover	karst sans forêt	procesos cársticos sin cubierta boscosa	карст не покрытый лесом
13.5.3		unterirdischer Karst	subterranean karst	karst souterrain	procesos cársticos subterráneos	подземный карст
13.6	violett / violet	<u>glazial / nival</u>	<u>glacial / nival</u>	<u>glaciaire / nival</u>	<u>glacial / nival</u>	<u>ледниковый / нивальный</u>
13.6.1		glazial, akkumulativ	glacial, accumulative	glaciaire, formations d'accumulation	glacial, acumulativo	ледниковый, аккумулятивный
13.6.2		glazial, exarativ	glacial, scouring	glaciaire, excavation	glacial, exarativo	ледниковый, ледниковое выпахивание / экзарация
13.6.3		Überformung durch austauendes Toteis	shaped by melting dead ice	remanié par glace morte fondante	transformación por fusión del hielo muerto	образованный таянием мертвого лда

13.7	lila lavender	<u>cryogen</u>	<u>cryogenic</u>	<u>cryogène</u>	<u>criogénico</u>	<u>криогенный</u>
13.7.1		periglazial	periglacial	périglaciaire	periglacial	перигляциальный
13.7.2		abluel (periglazifluvial)	abluel	périglacifluviatile	"abluel" / periglacifluvial	образованный флювиальными процессами в перигляциальных условиях
13.7.3		periglazial, Hänge von Schichtstufen	periglacial, slopes of cuesta scarps	périglaciaire, versants de cuestas	periglacial, frentes de cuestas	перигляциальный, склоны куэст
13.7.4		periglazial, Dellen	periglacial, depressions ("Dellen")	périglaciaire, delles	periglacial, Dellen	перигляциальный, делли
13.8	hellgrün light green	<u>fluvial</u>	<u>fluvial</u>	<u>fluviatile</u>	<u>fluvial</u>	<u>флювиальный</u>
13.8.1		chronologische Verschiedenheiten bei fluvialen Sedimenten: hell/jünger, dunkel/älter	chronological differences of fluvial sediments: light/younger, dark/older	différenciations chronologiques de dépôts fluviatiles: clair/ plus récent, foncé/plus ancien	cronología para sedimentos fluviales: claro / joven, oscuro / antiguo	возраст флювиальных отложений светлый оттенок - более молодой, темный оттенок - более древний
13.8.2		fluvial, vorwiegend im Holozän durch Hochwasser geformte Gebiete	fluvial, areas shaped by floods predominantly during the Holocene	fluviatile, régions aux formes dues à l'action des eaux de crues à l'Holocène	fluvial, áreas formadas principalmente por crecidas holocénicas	флювиальный, образованный преимущественно паводками в голоцене
13.8.3		fluvial, ehemaliger Flußlauf und Hochwasserrinne	fluvial, former channel of the River and flood channel	fluviatile, anciens cours et chenal d'écoulement de crue	fluvial, antiguo cauce del río y cauce de crecida	флювиальный, древнее русло реки Некар и паводковое русло
13.8.4		fluvial,Bereich holozäner Schwemmkegel- und Hangfußsedimentation	fluvial, area with small Holocene alluvial cones and colluvial deposits at slope feet	fluviatile, domaine de la sédimentation holocène de cônes alluviaux et de pied de versant	fluvial, área de sedimentación holocénica de conos y detritos de faldeo	флювиальный, район конусов выноса и аккумуляции у подножья склонов в голоцене
13.8.5		fluvial, Aufragung von Niederterrassensedimenten	fluvial, remnants of Low terrace sediments	fluviatile, affleurement de dépôts de basse terrasse	fluvial, remanentes de terraza baja	флювиальный, остатки отложений низких террас
13.8.6		fluvial, junge Akkumulationen	fluvial, younger accumulations	fluviatile, accumulations récentes	fluvial, acumulación reciente	флювиальный, молодая аккумуляция
13.8.7		fluvial, alte Akkumulationen	fluvial, older accumulations	fluviatile, accumulations anciennes	fluvial, acumulación antigua	флювиальный, древная аккумуляция
13.8.8		fluvial, Terrassen ungegliedert	fluvial, terraces not chronologically differentiated	fluviatile, terrasses indifférenciées	fluvial, terrazas sin cronología	
13.8.9		fluvial, holozäne Hochwasserbereiche	fluvial, Holocene flood plains	fluviatile, lit d'inondation exceptionnel holocène	fluvial, áreas de inundación holocénicas	флювиальный, речные террасы не расчлененные
13.8.10		fluvial, rezente Auen und Niederterrassen	fluvial, recent flood plains and Low terraces	fluviatile, lits d'inondation actuels et basses terrasses	fluvial, planicie aluvial reciente y terrazas bajas	флювиальный, голоценовая пойма
13.8.11		fluvial, Mittelterrasse	fluvial, Middle terrace	fluviatile, terrasse moyenne	fluvial, terraza media	флювиальный, современная пойма и низкие террасы
13.8.12		fluvial, Hauptterrasse	fluvial, Main terrace	fluviatile, terrasse principale	fluvial, terraza principal	флювиальный, средние террсы
13.8.13		ehemalige Flußläufe zur Niederterrassen-, Mittel- und Hauptterrassenzeit	former river beds at Low, Middle and Main Terrace times	anciens chenaux des époques des basses, moyennes et principales terrasses	cauces antiguos sincrónicos con las terrazas baja, media y principal	флювиальный, основная терраса
13.8.14		fluvial (Talböden, Schwemmfächer, Terrassen)	fluvial (valley floors, alluvial fans, terraces)	fluviatile (fonds de vallées, cônes alluviaux, terrasses)	fluvial (fondos de valle, conos aluviales, terrazas)	древние русла из времен низких, средних и высоких террас

13.9	dunkelgrün / dark green	**glazifluvial**	**glaciofluvial**	**glaciofluvial**	**glacifluvial**	**флювиогляциальный**
13.9.1		glazifluvial, Akkumulation	glaciofluvial, accumulation	glaciofluvial, accumulation	glacifluvial, acumulación	флювиогляциальный, аккумулятивный
13.9.2		glazifluvial, erosiv	glaciofluvial, erosion	glaciofluvial, ablation	glacifluvial, erosivo	флювиогляциальный, эрозионный
13.9.3		glazifluvial bis subglazi-fluvial, erosiv (Schmelzwasserrinnen)	glaciofluvial to subglacio-fluvial (meltwater channels)	glaciofluvial, évtl. sous-glaci-aire, ablation (chenal d'écoule-ment des eaux de fonte)	glacifluvial o subglacifluvial, erosivo (cauce glacifluvial)	флювиогляциальный и подледниково-флювиальный эрозионный (русла талых вод)
13.10	ocker / ochre	**denudativ**	**denudational**	**faconnement aréal**	**denudativo**	**денудационный**
13.10.1		denudativ, hangial	denudational	faconnement aréal de versants	denudativo, "hangial"	денудационный, склоновый
13.10.2		denudativ, Fußflächenbereiche	denudational, pediments	faconnement aréal, domaine des glacis	denudativo, áreas de pedimentación	леиудационный, педиметы
13.10.3		denudativ, Hangflächen mit geringer Schuttbedeckung	denudational, slopes with thin debris cover	faconnement aréal, portions de versant peu couverts	denudativo, laderas con escasa cobertura de detritos	денудационный, склоны с маломощным плащем склоновых отложений
13.10.4		denudativ, Talhangbereiche	denudational, valley slopes	faconnement aréal, versants de vallées	denudativo, vertientes de valle	денудационный, склоны долин
13.10.5		denudativ, kolluvial	denudational, colluvial	faconnement aréal, colluvial	denudativo, coluvial	денудационный, коллювиальный
13.10.6		denudativ, Bereich allge-meiner Hangformung	denudational, areas of slope formation unspecified	faconnement aréal indifferencié de versants	denudativo, formación de vertien-tes en general	денудационный, общее формирование склонов
13.10.7		denudativ, Hangformung durch Rutschungen	denudational slumping	faconnement aréal par glisse-ments	denudativo, formación de vertien-tes por deslizamiento	денудационный, сформированый оползнями
13.10.8		denudativ, Bereich vorzeitiger Flächenformung	denudational, former planation surfaces	faconnement aréal, aplanisse-ments anciens	denudativo, área de aplanamiento antiguo	денудационный, древние поверхности выравнивания
13.10.9		denudativ, marin überformt, nur bei Sturmfluten überflu-teter Bereich (Außengroden)	denudational, modified by marine processes, high tidal marsh ("Außengroden")	faconnement aréal, remaniement marin, domaine submergé seule-ment en cas de très haute marée ("Aussengroden")	denudativo, transformado por pro-cesos marinos, sólo inundado por mareas vivas o excepcionales ("Aussengroden")	денудационный, переработанный морскими процессами, покрытый водой во время высокого прилива (аусенгроден)
13.10.10		denudativ, durch Deiche geschützte Marsch (Innengroden)	denudational, marshland protected by dikes ("Innengroden")	faconnement aréal, marais litto-ral, protégé par des digues ("Innengroden")	denudativo, marjal protejido por diques ("Innengroden")	денудационный, марш ограниченный дамбами (инненгроден)
13.11.	rotbraun / reddish brown	**strukturell**	**structural**	**réliefs structuraux**	**estructural**	**структурный**
13.11.1		Strukturfläche	structurally controlled surface / stripped surface	surface structurale	superficie controlada estructu-ralmente	структурные поверхности
13.11.2		strukturell, denudativ über-prägt, Hochflächenbereiche	structural, modified by denudational processes, higher plateaus	structural, remanié par faconne-ment aréal, domaine de hauts pla-teaux	estructural, levemente alterado por procesos denudativos, alti-planicies	структурный, переработанный денудацией, высокие плато
13.11.3		strukturell, Dachflächen der Schichtstufen	structural, surface of cuesta scarps	structural, revers de cuesta	estructural, altiplanicies de cuestas	структурный, тыловые склоны куэс

13.12	braun / brown	**gravitativ**	**gravitational**	**faconnement par gravité**	**gravitativo**	**гравитационный**
13.13	oliv / olive	**organogen**	**organic**	**organogène**	**orgánico**	**органический**
13.13.1		telmatisch	mostly low fen formations	bas-champs	palustre	преимущественно низинный
13.14	dunkelgrau / dark grey	**anthropogen**	**anthropogenic**	**anthropique**	**antropogénico**	**антропогенный**
13.14.1		anthropogene Überformung	landforms due to human impact	remaniement anthropique	modificación por impacto antrópico	антропогенная переработка
13.14.2		stark anthropogen überformte Gebiete	landforms strongly modified by human impact	régions à profonds remaniements anthropiques	áreas fuertemente modificadas por impacto antrópico	районы сильной антропогенной переработки
13.14.3		anthropogen, durch Siedlung überformt	anthropogenic, modified by settlements	anthropique, marqué par l'habitat	antropogénico, modificado por asentamientos	антропогенный, переработанный населенными пунктами
13.14.4		anthropogen bedingte Akkumulation (kleiner 1 m)	anthropogenic accumulation (smaller than 1m)	accumulation anthropique (moins de 1 m)	acumulación antropogénica (menor de 1 m)	антропогенная аккумуляция (мощность менше I м)
13.14.5		anthropogen, Aufschüttung	anthropogenic, accumulation	dépôt anthropique	antropogénico, acumulación	антропогенная аккумуляция
13.14.6		anthropogen, Weinberge	anthropogenic, vineyards	anthropique, vignoble	antropogénico, vinedos	антропогенный, виноградник
13.14.7		anthropogen, Überformung eines Flußbettes, Sohlenvertiefung / Sohlenerhöhung	anthropogenic, canalization dregde / fill of river bed	anthropique, aménagement d'un cours d'eau, sucreusement artificiel / exhaussement artificiel du fond du lit	antropogénico, profundización o relleno de cauces	антропогенный, переработка русел / углубление, заполнение
13.15	orangerot / orange	**aktuell**	**present-day**	**actuel**	**actual**	**современные формы, процессы**
13.15.1		aktuell, Rutschungen	recent slumping	actuel, plissements	actual, deslizamiento	современный, оползень
13.15.2		aktuell, Trockenschutthalden	recent talus slopes	actuel, talus d'éboulis	actual, cono de derrubios	современный, осыпной склон
13.16	gelb / lila / gelb	**polygenetische Prozeßbereiche** z.B. äolisch, cryogen überformt (Löß, periglazial verlagert)	**polygenetic areas** e.g.aeolian, modified by cryogenic processes (periglacial deluvial loess)	**domaines polygénétiques** p.ex. éolien, remaniement cryogène (loess, remanié par action périglaciaire)	**áreas poligenéticas** ej. eólico, modificado por procesos geocriogénicos (loes con retransporte periglacial)	**полигенетические районы** например эоловые с криогенной переработкой (лесс переработанный в перигляциальных условиях)
14	blau / blue	**Hydrographie**	**hydrography**	**hydrographie**	**Hidrografia**	**Гидрография**
14.1		Gewässer, perennierend	perennial strems and lakes	cours d'eau pérenne	aguas corrientes y lagos permanentes	реки, постоянные
14.2		natürlicher See mit Abfluß	natural lake with outlet	lac naturel avec exutoire	lago natural con emisario	озеро с истоком

14.3	Seeabfluß	surface outlet of lake	exutoire de lac	emisario	исток озера
14.4	See ohne Abfluß	lake without outlet	lac sans exutoire	lago sin desagüe	бессточное озеро
14.5	Teich	pond	étang	estanque	пруд
14.6	Teich mit Staudamm	pond with dam	étang avec digue de retenue	dique de embalse	пруд с дамбой
14.7	künstlicher See	man-made lake	lac artificiel	lago artificial	искусственный водоем
14.8	künstlicher See ohne Abfluß	artificial lake without outlet	lac artificiel sans exutoire	lago artificial sin desagüe	искусственный бессточный водоем
14.9	künstlicher See durch Sandentnahme	lake due to groundwater in sand pit	lac de sablière	lago artificial por extracción de arena	искусственное озеро в выемке по добычи песка
14.10	künstlicher See durch Kiesentnahme	lake due to groundwater in gravel pit	lac de gravière	lago artificial por extracción de gravas	искусственное озеро в быемке по добычи гравия
14.11	episodischer Karstsee	intermittent karst lake	lac karstique épisodique	lago cárstico intermitente	эпизодическое карстовое озеро
14.12	See, Wasserspiegelerhaltung durch künstliche Einleitung von Oberflächenwasser	lake, artificial water level due to input of river and rainwater	lac, niveau maintenu artificiellement par apport d'eau de surface	lago, nivel suplementado por recolección de agua superficial	озеро, уровень которого искусственного поддерживается речной или атмосферной водой
14.13	Gewässer, zeitweise fließend (periodisch oder episodisch)	intermittent stream and lake	cours d'eau périodique ou épisodique	aguas corrientes no permanentes (periódicas o episódicas)	пересыхающая река
14.14	natürliches Gewässer, zeitweise fließend	natural intermittent stream	cours d'eau naturel intermittent	corriente natural no permanente	естественные воды, пересыхающие
14.15	natürliches Gewässer, ständig fließend	natural perennial stream	cours d'eau naturel pérenne	corriente natural permanente	естественные воды, постоянные
14.16	natürliches Gerinne, künstlich verändert	natural stream, modified by man	chenal naturel modifié par l'homme	corriente natural, modificada por el hombre	естественные реки, изменные человеком
14.17	natürliches Gewässer, streckenweise reguliert	perennial stream, partly canalized	cours d'eau naturel partiellement aménagé	corriente natural, parcialmente canalizada	естественные реки, частично регулированные
14.18	Gewässer, reguliert, perennierend	canalized perennial stream	cours d'eau aménagé pérenne	corriente permanente, regulada	естественные реки, с постоянным регулированием
14.19	Gewässer, z.T. reguliert	stream, partly canalized	cours d'eau, partiellement aménagé	corriente, parcialmente regulada	реки, частично регулированные
14.20	künstliches Gewässer, ständig fließend	perennial artificial drainageway	chenal artificiel pérenne	corriente artificial, permanente	искусственные реки, постоянные
14.21	künstliches Gewässer, zeitweise fließend	intermittent artificial drainageway	chenal artificiel intermittent	corriente artificial no permanente	искусственные реки, пересыхающне
14.22	Be- und Entwässerungsgraben	irrigation / drainage ditch	fossé d'irrigation, fossé de drainage	canal de riego / canal de drenaje	ирригационная канава / дренажная канава
14.23	unterirdischer Abfluß	subsurface drainage	écoulement souterrain	escurrimiento subterráneo	закрытый дренаж
14.24	Abfluß, verrohrt	drain pipes	captage	desagüe entubado	дрена

14.25		unterirdischer künstlicher Zufluß	artificial subsurface inflow	affluent artificiel souterrain	flujo artificial subterráneo	искусственный подземный приток
14.26		Überflutungsbereich, zeitweilig unter Oberflächenwasser stehend	occasionally flooded	lit d'inondation accasionnel	área ocasionalmente inundada	эпизодически заливаемые участки
14.27		Uferlinie eines Stausees	shoreline of reservoir	tracé des rives d'un lac de retenue	línea de costa de embalse	береговая линия подпруженного водоема
14.28		hochwassergefährdeter Bereich	boundary of potentially flooded area	domaine menacé d'inondation potentielle	área con riesgo de inundación	граница района возможных наводнений
14.29		oberflächennahes Grundwasser (1 m unter Flur)	watertable near surface (1 m below surface)	toit de la nappe à moins de 1m de profondeur	napa freática cercana a la superficie (1 m bajo la superficie)	уровень грунтовых вод вблизи поверхности (до глубины I м)
14.30		Vernässung	waterlogged / swampy	mouillère	anegamiento	грунт насыщенный водой, заболоченный участок
14.31		Staunässe	impeded drainage	domaine humide par drainage localement déficient	drenaje restringido / impedido	заболоченный участок подпруженный естественной плотиной
14.32		Quellnässe	spring wetness / seepage	niche de source déterminant un point de saturation en eau	manantial	просачивание
14.33		Quelle	spring	source	manantial, fuente	источник, родник
14.34		Quelle, ständig fließend, ungefaßt	perennial spring, not encased	source pérenne, non captée	manantial permanente, no contenido	источник, постоянный, естественный
14.35		Quelle, ständig fließend, gefaßt	perennial spring, encased	source pérenne, captée	manantial permanente, contenido	источник, постоянный, использованный для водоснабжения
14.36		Quelle, zeitweise fließend, ungefaßt	intermittent spring, not encased	source épisodique non captée	manantial intermitente, no contenido	источник, пересыхающий, естественный
14.37		Quelle, zeitweise fließend, gefaßt	intermittent spring, encased	source épisodique captée	manantial intermitente, contenido	источник, пересыхающий, использованный для водоснабжения
14.38		Karstquelle	karst spring	source karstique	fuente cárstica	карстовый источник
14.39	A	artesische Quelle, gefaßt	artesian spring, encased	source artésienne captée	surgente, fuente artesiana contenida	артезианский источник, использованный для водоснабжения
14.40		Schluckloch	ponor / swallow hole	ponor	ponor / sumidero	понор
14.41		Stromschnelle, Wasserfall	rapid, waterfall	rapide, cascade	rápido, salto, catarata	пороги, водопад
14.42		Wehr, Staustufe	weir	petit barrage fluvial, seuil fluvial artificiel	dique, muro de contención	запруда, плотина, водослив
14.43		Schleuse	sluice	écluse	esclusa	шлюз
14.44		Brunnen	well	fontaine	pozo para extracción de agua	колодец
14.45	Bs	Brunnenstube	well chamber	chambre de fontaine	pozo con cámara	здание колодца

14.46		Wasserbehälter	watertank	réservoir d'eau	tanque de agua	резервуар
14.47	Pw	Pumpwerk	pumping station	stations de pompage	estación de bombeo	водокачка, водонапорная станция
14.48		Rückhaltebecken	water retaining basin	bassin de retenue	embalse	водохранилище
14.49		Rückhaltebecken, geplant	water retaining basin, planned	bassin de retenue prévu	embalse, planificado	регулируемое водохранилище
14.50		Kläranlage	clarification plant	bassin d'épuration	planta de clarificación, estación depuradora	водоочистная станция
14.51		Weg mit Abflußfunktion in Weinbergen	road with discharge in vineyards	chemin guidant l'écoulement dans les vignobles	camino con función de drenaje en vinedos	дорога выпольняющая функцию дренажа в виноградниках
14.52		Betonschalen zur Abflußregelung in Weinbergen	concrete drainage channel in vineyards	conduits bétonnés pour l'écoulement dans les vignobles	canales de hormigón en vinedos para regular el drenaje	бетонный дренаж в виноградниках
14.53		Abflußmenge Jahresmittel / Minimum / Maximum (1/sec)	discharge annual mean / minimum / maximum (1/sec)	débit module/minimum/maximum (1/sec)	descarga promedio anual / mínimo / máximo (1/seg.)	сток, средний годовой / минимальный / максимальный (Л/С)
14.54		sommerlicher Schmelzwasserabfluß mit glazialem Regime	meltwater stream with glacial regime	écoulement d'eau de fonte estival à régime glaciaire	corriente estival de agua de fusión con régimen glacial	летний сток талых вод с ледниковым режином
14.55		periodische, periglaziale Abflußbahnen mit nivalem Regime	meltwater drainageway with nival regime	drains périodiques périglaciaires à régime nival	cauces de corrientes periódicas periglaciales con régimen nival	периодические перигляциальные линии стока с нивальным режином
14.56		episodischer Abfluß	episodic runoff	écoulement épisodique	escurrimiento episódico	эпизодический сток
14.57		Altarme	oxbow lakes	bras morts	brazo abandonado	старица, пойменное озеро
14.58		Aufeis	"Aufeis" / icing	hydrolaccolithe	ríos y vertientes congelados "icings"	тарый, наледь
14.59		Meer mit Meereis	sea with sea-ice		mar con cubierta congelada	море с морским льдом
14.60		Gletscher	glacier	glacier	glaciar	ледник
14.61		Gletscher- und Firnflecken	glaciers and névé patches	taches de glace pérenne et de névé	pequenos glaciares y manchones de nieve	ледник и снежник

SUPPLEMENTS and SITUATION
areal and topographic relief characteristic

15		Ergänzende Angaben	supplementary informations	indications complémentaires	Informaciones complementarias	Дополнительные данные
		Signaturen bei Breite kleiner/gleich 100 m	conventional sign for width minor/equal 100 m	signes pour une largeur inférieure à 100 m	signos convencionales para un ancho igual o menor que 100 m	сигнатуры при ширине меньше как 100 м
		Abkürzungen bei Breite größer 100 m	abbreviations for width more than 100 m	abréviations pour une largeur supérieure à 100 m	abreviaturas para un ancho mayor que 100 m	сокращения при ширине больше как 100 м
15.1	Hl	Höhle	cave	grotte	cueva, caverna	пещера
15.2	Hd	Halde	dump / mine tip	déblai de mine	cascote, escombros	отвал
15.3	Pg	Pinge	smaller forms due to mining	formes mineures liées à l'exploitation minière	pequena depresión por explotación minera	провальная воронка
15.4		Schieferstollen, aufgelassen	shale adit, abandoned	galerie d'exploitation d'ardoise, abandonnée	galería en esquistos, abandonada	штольная для добыча сланца, оставленная
15.5		tiefer Schacht	deep shaft	puits de mine profond	foso profundo	глубокая шахта
15.6	Tg	Tongrube	clay pit	glaisière	mina de arcilla	карьер для добычи глины
15.7	Lg	Lehmgrube	loam pit	loessière	explotación de légamo	карьер для добычи суглинков
15.8	Sg	Sandgrube	sand pit	sablière	cantera de arena	песчаный карьер
15.9	Kg	Kiesgrube	gravel pit	gravière	cantera de gravas	гравийный карьер
15.10	Sb	Steinbruch	quarry	carrière	cantera	каменоломная
15.11	Tb	Tagebau	opencast mining	exploitation à ciel ouvert	explotación minera a cielo abierto	открытая разработка
15.12		Torfstich	peat cutting	exploitation de tourbière	extracción de turba	добыча торфа
15.13	Kl	Kleientnahmefläche	excavation of marine clay	excavation d'argile marine	área de explotación de sedimentos marinos	добыча морской глины
15.14		ehemalige Ziegelei, Pechbrennerei und Köhlerplatz	former brick, pitch and charcoal works	anciennes tuilleries, et localisation d'activité charbonnière	fábrica de ladrillos abandonada, sitio de producción de brea y carbón de lena	кирпичный завод, оставленный смольной завод, призводство древесного угля
15.15	Bg	Baggerloch im Watt	dregde hole in tidal flat	trou de dragage dans le domaine intertidal	dragado en área de bajamar	выемка по землечерпалке в приливно-отливной отмели
15.16	Md	Mülldeponie	rubbish dump	dépôts d'ordures	depósitos de basura	свалка
15.17		Feuerschutzgräben an Bahndämmen	fire-protection ditches along railway embankments	fossés anti-incendie le long de remblais ferroviaires	fosas contra el fuego a lo largo de los terraplenes del ferrocarril	противопожарная канава железной дороги

	grau grey					
15.18		ehemaliger Bunker	destroyed fortification	ancien ouvrage de défense militaire en béton	Bunker abandonado	оставленный дот, оставленный бункер
15.19		Opferkessel in Sandstein	solution pit in sandstone	formes de dissolution dans le grès	marmitas de disolución en areniscas	орисанги в песчаниках
15.20		Hügelgrab	burial mound	tumulus	túmulo prehistórico	курган
15.21		Schanze	fortification	fortification en terre	trinchera	укрепление
15.22		frühgeschichtliche Wallanlage	prehistoric wall	remblai préhistorique	terraplén protohistórico	доисторический вал
15.23		Fossilien	fossils	fossiles	fósiles	остатки ископаемых
15.24	1895	Jahr der Eindeichung	year of poldering	année de la construction de la digue du polder	fecha de construcción de un polder	год образования польдера
15.25	A	Aufschüttungsgelände	landfill site	terrain remblayé	área de rellenamiento antrópico	место захоронения отходов
15.26		Profillinien	profile lines	lignes de profils	líneas de perfiles	линия профиля
15.27	T	Bohrung, Sondierung	drilling site, sounding	sondage, oricangas	perforación, sondeo	устья буровых скважин, зондирование
15.28		Grabung, Aufschluß	section	fosse pédologique, coupe	excavación, corte	разрез, шурф
15.29		Entnahmestelle der Proben	site of sample	points de prélèvement des échantillons	sitio de muestreo	место отбора проб
15.30	8 | 0	Auftaumächtigkeit in cm	thickness of active layer in cm	épaisseur de la couche active en cm	espesor de la capa activa en cm	мощность деятельного слоя в сантриметрах

16. Topographic situation and position

Topographic situation and position is given by the grey print of the topographic map 1 : 25 000 with the Gauss-Krüger map grid. The topographic map base is to be corrected by geomorphological mapping with respect to the drainage net and the signs concerning breaks of slopes.

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