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## River valleys of the Mazovian Interglacial in eastern Central Europe

**ABSTRACT:** A reconstructed pattern of main river valleys of the Mazovian (Mindel II/Riss I; Holstein in Germany) Interglacial for eastern Central Europe is considerably different from those presented previously. This pattern comprises the pre-Vistula and pre-Neman drainage basins, both entering northwards to the Holstein Sea bay and including the Sambia region, as well as of the pre-Warta/Odra and pre-Noteć drainage basins, running westwards into the Holstein Sea bay that reached the present-day Lower Elbe area. The development of this valley system depended upon the extent of glaciodynamic structures and deglaciation after the Sanian (= Mindel II) Glaciation as well as upon the results of neotectonic movements.

### INTRODUCTION

Floristic localities of the Mazovian Interglacial, limited by tills of the Sanian (= Mindel II, Elstera II, Oka II) and the Odranian (= Riss I, Saale 1–2, Dnieper) glaciations or their residua, and corresponding alluvial series represent several successive interglacial warmings in eastern Central Europe (Różycki 1961, 1964, 1967; Rühle 1973). The works undertaken during the last ten years proved that some localities represent the real interglacial whereas some of them are younger and represent the anaglacial warmings of the Odranian Glaciation (Różycki 1972, 1978, 1980; Lindner 1981).

Janczyk-Kopikowa (1980) suggested recently that the earlier localities of this interglacial (Ferdynandów, Podgórze, Łuków, Białobrzegi, Podłodów) differ much

from the later localities (Barkowice Mokre B, Olszewice, Sewerynow, Krępiec, Ciechanki Krzesimowski, Syrniki) also by another plant succession but first of all, by a more abundant content of *Quercus*, *Ulmus* and *Tilia*, a small content of *Picea* and absence of *Carpinus* and *Abies*; the earlier localities represent the Ferdynandów Interglacial whereas the younger ones — the real Mazovian Interglacial corresponding with a transgression of the Holstein Sea. Lindner & Grzybowski (1982) placed both these intervals into the Mazovian Interglacial and, in the case of the Central Poland, defined its older part as the Radom one and the younger part as the Opoczno one. In the Central Poland the earlier localities of the Mazovian Interglacial come from the postglacial lakes, formed after a retreat of the icesheet of the Sanian Glaciation whereas the younger ones occur usually within the river valleys (Różycki 1964, 1972; Lindner 1981).

The data on the Quaternary of the European part of the Soviet Union (Cepulyte 1976, Loginova 1979), of Poland (Kopczyńska-Zandar-ska 1970; Baraniecka & Sarnacka 1971; Lindner 1971, 1977, 1978; Ber 1974; Nowak 1974; Słowański 1975; Kozłowska 1976; Ruszczyńska-Szenajch 1976, 1978; Baraniecka & al. 1978; Sarnacka 1977, 1978; Maksiak & Mróz 1978; Mojski 1979; Makowska 1980; Dąbrowski 1982; Harasimiuk & Henkiel 1981; Lamparski 1981, 1982) and of German Democratic Republic (Cepek & al. 1975) enabled to reconstruct these valleys in eastern Central Europe (Text-figs 1—6). The received paleogeographic image, together with a probable extent of the Holstein Sea, is considerably different from that previously know (cf. Mojski & Rühle 1965, Różycki 1965, Rühle 1973).

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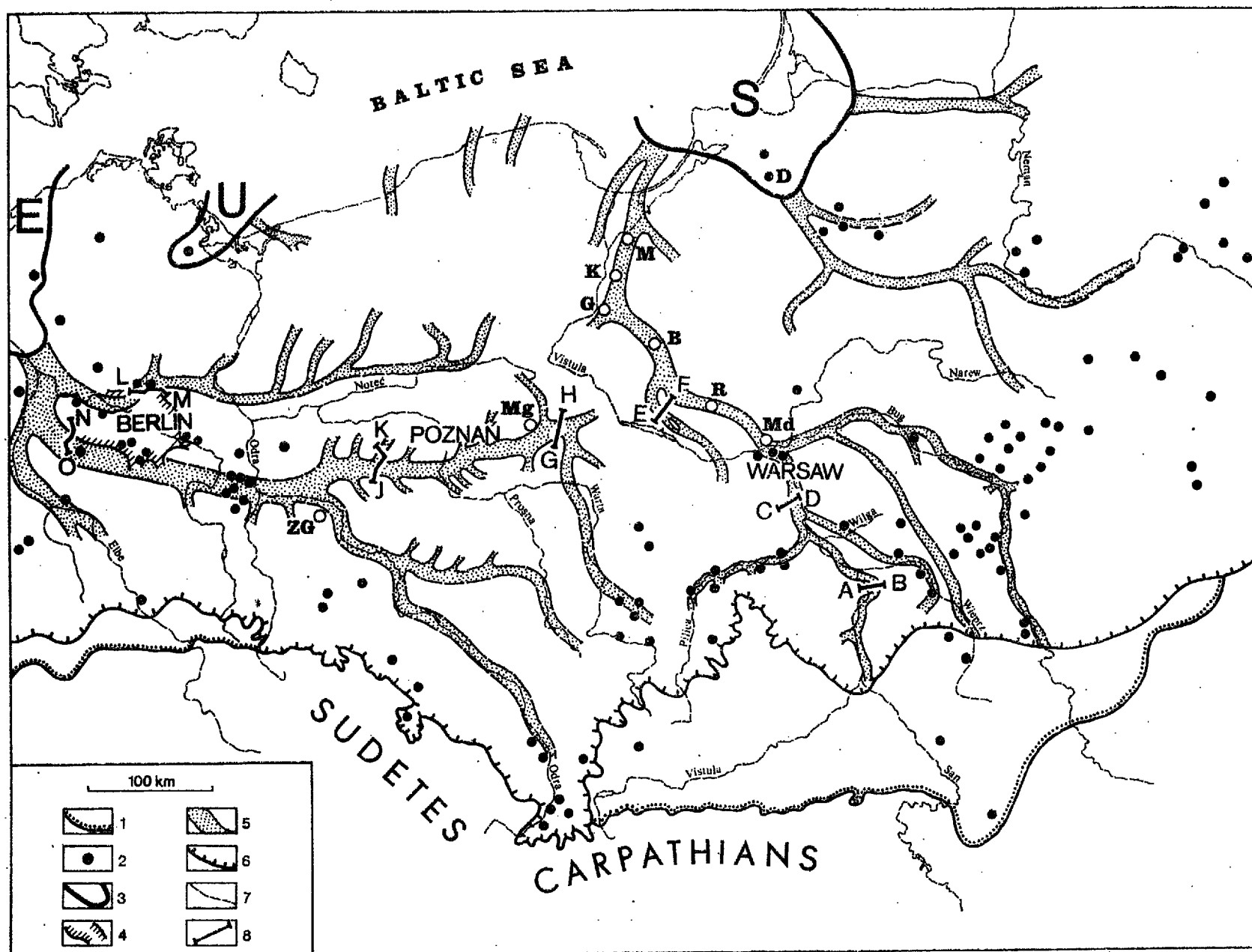
## GEOLOGIC SETTING

A reconstruction of the main river valleys of the Mazovian Interglacial in the discussed area was based on analysis of several thousand boreholes, set together in geological sections, some of which are presented in this paper (Text-figs 2—6).

### SECTION AT PUŁAWY

In the Puławy region (section A—B in Text-figs 1—2), the pre-Vistula valley of the Mazovian Interglacial was situated to the east of the present valley (Text-figs 1—2) and covered by ice-dammed and glacial sediments of the Odranian Glaciation; in places where the latter are carried away, there is a cover of aeolian sands of Vistulian Glaciation and Holocene age. The valley is cut in pre-

## Paleogeographic sketch of eastern Central Europe during the Mazovian Interglacial (MII/RI)



1 extent of the Sanian Glaciation (MI); 2 localities of organogenic sediments of the Mazovian Interglacial (partly after: Straszewska & Stupnicka 1980, Cepek 1967, Loginova 1979); 3 extent of the Holstein Sea (after Cepek 1967, Loginova 1979); E — Lower Elbe bay, U — Uznam bay, S — Sambia bay; 4 extent of the so-called Paludina Bed (after Cepek 1967); 5 main river valleys of the Mazovian Interglacial, overlain by deposits of the Odranian Glaciation; 6 extent of the Odranian Glaciation (RI); 7 present main rivers; 8 geologic sections presented in Text-figs 2–6

Abbreviations for localities discussed in the text: ZG — Zielona Góra; Mg — Mogilno; D — Domnowo; M — Malbork; K — Kwidzyń; G — Grudziądz; B — Brodnica; R — Raciąż; Md — Modlin

-Quaternary sediments and its bottom occurs at about 80 m a.s.l. (about 60–80 m below the present land surface). It is filled by sandy-gravel alluvia, over 50 m thick and composed of at least four erosive-accumulative cycles.

According to Różycki (1972) and Lindner (1981) only the sediments of the two lowermost cycles can be connected with the Mazovian Interglacial whereas the upper cycles can already correspond to the anaglacial part of the Odranian Glaciation. After Różycki (1972) the valley runs from the Sandomierz Basin towards the Warsaw area, with a distinct gradient of 0.3–0.5 ‰ northwards.

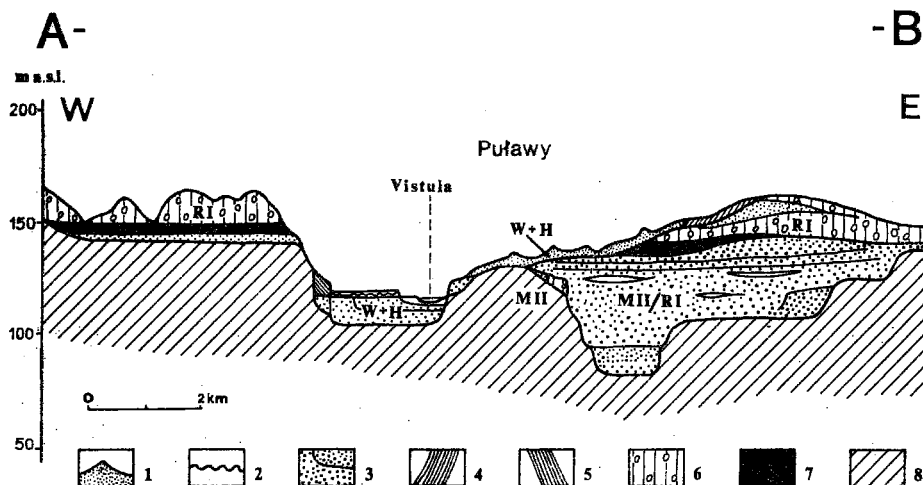


Fig. 2. Geologic section across the present and buried Vistula valley in the Puławy region (after Różycki 1972)

LITHOLOGY: 1 dunes, 2 muds and peat, 3 fluvial sands and gravels, 4–5 slope sediments, 6 tills, 7 varved clays, 8 Quaternary substrate

STRATIGRAPHY: **MI** — Sanian Glaciation, **MI/RI** — Mazovian Interglacial, **RI** — Odranian Glaciation, **W** — Vistulian Glaciation, **H** — Holocene

In the reach Puławy — Warsaw the valley was entered by the interglacial tributaries of the pre-Pilica and further to the north, of the pre-Wilga (cf. Text-fig. 1).

Basing on the papers of Łyczewska (1977) as well as of Harasimiuk & Henkiel (1981), the pre-Wieprz interglacial valley (located further to the east) after it passed the Lublin Upland, did not run along the present valley of that river but to the north-east, entering the interglacial pre-Bug valley (cf. Text-fig. 1).

#### SECTION AT ZABIENIEC

South of Warsaw, the pre-Vistula valley of the Mazovian Interglacial is documented at Żabieniec (section C—D in Text-figs 1 and 3). In this area the pre-Vistula valley is incised in sediments of the older glaciations

(Nidanian and Sanian) and the Protopleistocene; it reaches the pre-Quaternary rocks and its bottom occurs at about 40 m a.s.l. The valley is 4–6 km wide and filled with sandy-gravel sediments of three erosive-accumulative cycles. The sediments are up to 40 m thick. They are overlain by a sandy-gravel series with peat inserts corresponding, after Janczyk-Kopikowa (*in* Sarnacka 1977), with a cool interphase or interstadial. They are overlain by glacial, fluvioglacial and limnoglacial series of two younger glaciations (Odranian and Wartanian), separated by the intermorainic deposits.

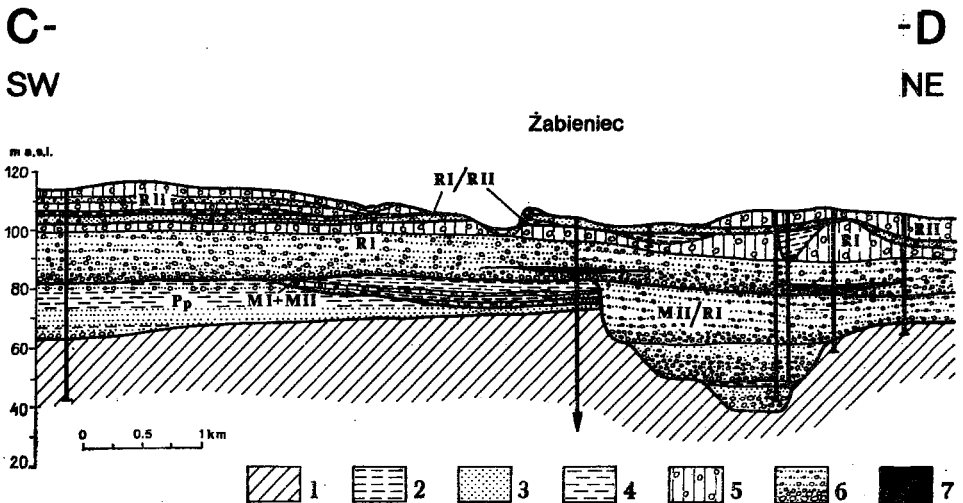


Fig. 3. Geologic section at Żabieniec (*after* Sarnacka 1977)

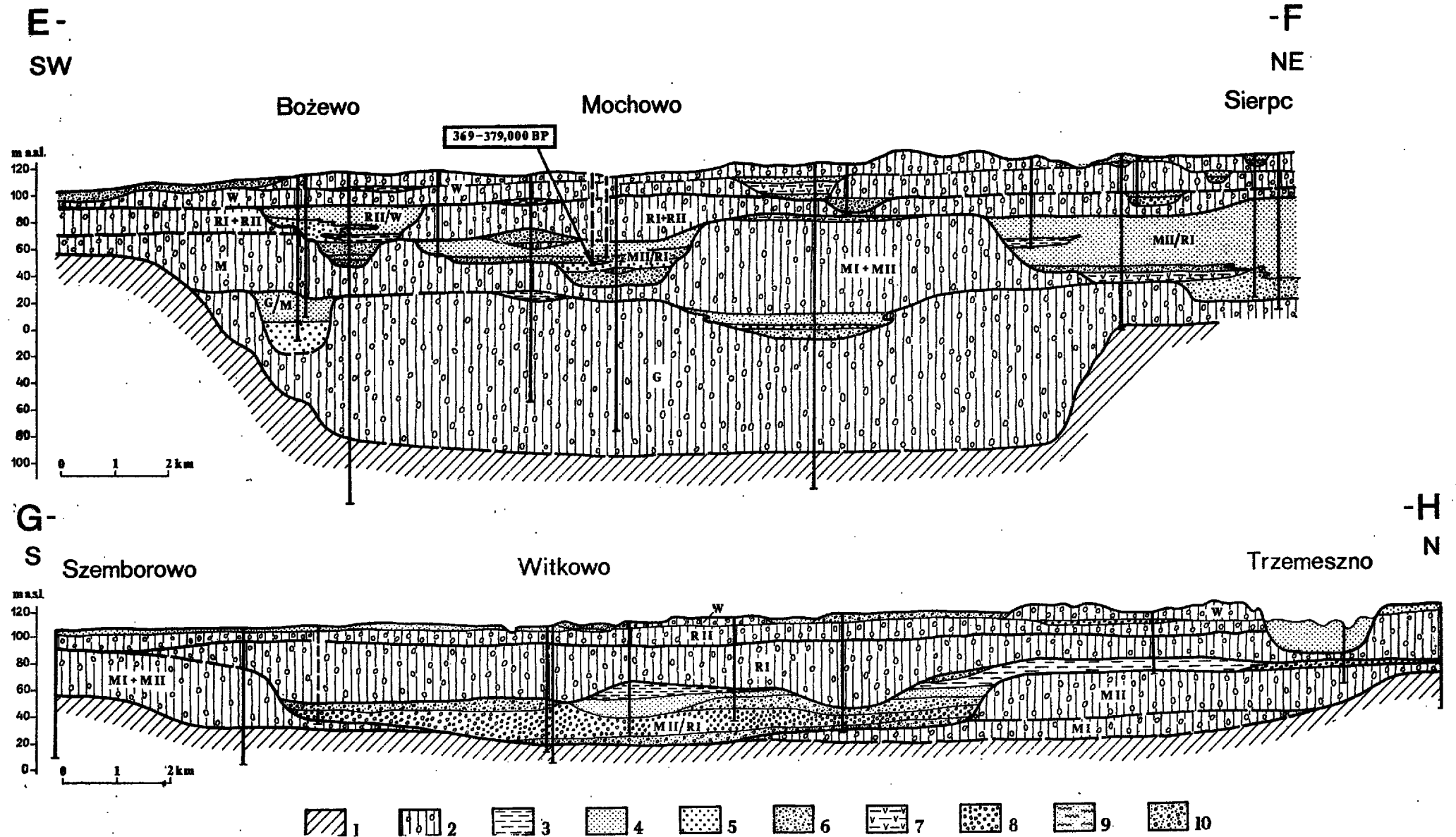
LITHOLOGY: 1 Quaternary substrate, 2 clays, 3 sands, 4 silts, 5 tills, 6 gravels and sands, 7 organogenic sediments

STRATIGRAPHY: Pp — Protopleistocene, MI — Nidanian Glaciation, MII — Sanian Glaciation, MII/RI — Mazovian Interglacial, RI — Odranian Glaciation, RI/RII — Wartanian Glaciation

Further to the north, the fluvial sediments of the pre-Vistula were noted in the Warsaw area (Różycki 1972, Nowak 1974, Baraniecka 1974). These sediments form several erosive-accumulative cycles. To the north of Warsaw the sediments of the oldest cycle occur at about 20 m a.s.l. and fill, after Baraniecka (1974), a meridional erosive depression.

To the north of Warsaw the valley was entered by the interglacial pre-Bug River (*cf.* Text-fig. 1). Its alluvia of that time, have been deposited in four main erosive-accumulative cycles whereas its bottom occurs at 20–30 m a.s.l. (Straszewska 1968).

Geologic sections Bożewo-Mochowo-Sierpc (after Lamparski 1981)  
and Szemborowo-Witkowo-Trzemeszno (after Dąbrowski 1982)



LITHOLOGY: 1 Quaternary substrate, 2 tills, 3 silts and clays (locally varved), 4 fine-grained sands, 5 coarse-grained sands, 6 vari-grained sands, 7 silts with clayey interbeddings, 8 gravels, 9 silty sands, 10 sands with gravels

STRATIGRAPHY: G — Narewian Glaciation, G/MI — Podlasiian Interglacial, MI — Nidanian Glaciation, MII — Sanian Glaciation, MII/RI — Mazovian Interglacial, RI — Odranian Glaciation, RII — Wartanian Glaciation, RII/W — Eemian Interglacial, W — Vistulian Glaciation

## SECTION NEAR SIERPC

The valleys of the Mazovian Interglacial near Sierpc (section E—F in Text-figs 1 and 4) were recognized by several boreholes. Its considerable width (over 4 km), bottom at a sea level and the infilling sediments prove that it represents a successive, lower reach of the pre-Vistula valley. The interglacial alluvia of this river compose of two erosive-accumulative cycles and are overlain by two tills of the Middle-Polish glaciations (Odranian and Wartanian) as well as of the Vistulian Glaciation. The second valley was identified in the Mochowo region (Text-fig. 4); it is filled with alluvia of two erosive-accumulative cycles. The sediments of the younger cycle were thermoluminescence dated for 369—379 000 years B. P. (Lamparski 1981) indicating the middle part of the Likhvin Interglacial (cf. Sudakova & Aleshinskaya 1974). The valley bottom occurs at 20 m a.s.l. and its width is equal 3—4 km. The valley is expected to have been formed by the western tributary of the pre-Vistula.

The lower reach of the Mazovian Interglacial pre-Vistula was identified in boreholes of the Brodnica area and in the present Lower Vistula valley (Makowska 1980). Between Sierpc and Grudziądz the pre-Vistula alluvia of that time are preserved at 0—30 m a.s.l. whereas between Kwidzyń and Malbork they get down to 60—40 m b.s.l. (60—80 m below the present land surface). A lithology of these sediments proves a valley formed by the river entering a non-far reservoir, presumably the bay of the Holstein Sea, covering the Sambia region and to the south of Kaliningrad (Kondratyene 1966, Cheremisina 1970) as far as the Domnovo locality (Loginova 1979). The boreholes from the Mazury Lakeland prove that during the Mazovian Interglacial this bay could be entered by a river that drained the north-eastern part of this Lakeland (Ber 1974): most probably, it was the pre-Neman River with a southern tributary of the pre-Narew River (cf. Text-fig. 1).

## SECTION SZEMBORÓWO—WITKOWO—TRZEMESZNO

The Mazovian Interglacial valley at the western slope of the Mid-Polish Anticlinorium (section G—H in Text-figs 1 and 4) forms a fragment of a wide-spread valley system recognized in the Wielkopolska Lowland (Dąbrowski 1982). In the Witkowo area the valley bottom, after cutting the tills of the South-Polish Glaciations (Nidanian and Sanian), reaches the pre-Quaternary rocks and occurs at 0—20 m a.s.l. It is up to 10 km wide and filled with sandy-gravel alluvia (30—40 m thick) of at least two erosive-accumulative cycles. The series is covered by ice-dammed and fluvioglacial sediments, overlain by tills of the Middle-Polish Glaciations (Odranian and Wartanian) as well as by fluvioglacial sediments and a till of the Vistulian Glaciation.

A considerable width of the valley and continuation of its upper branches to the west suggested (Dąbrowski 1982) that it could be a fragment of the interglacial valley system of the pre-Vistula. But the following analysis of boreholes from the Kujawy region seems to exclude such possibility and tends to consider this valley for a fragment of the pre-Warta interglacial valley that collected waters from the western part of Central Poland and formed a parallel, westward valley system documented by boreholes at its almost 200 km long course.

## SECTION NOWY TOMYŚL—WYTOMYŚL—LWÓWEK

The section (J—K in Text-figs 1 and 5) documents the lower reach of the interglacial pre-Warta valley. The valley bottom is, after a removal of tills of older glaciations, incised in the Quaternary substrate and occurs at the present sea level. The valley is filled with sands and gravels of two erosive-accumulative cycles that occur in the whole, almost 20 km wide valley; they are over 20 m thick and overlain by fluvioglacial sands, deposited during the advance of the icesheet of the Odranian Glaciation; the latter is recorded by a till horizon. Above, there are fluvioglacial and glacial sediments of the Wartanian Glaciation and of the Vistulian Glaciation. A confrontation of the valley bottom gradients along its whole, almost 200 km long reach, proved its concordant slope of about 1—2 ‰ westwards. Near Lwówek a tributary of this river was noted.

Further to the west, to the north of Zielona Góra, the interglacial pre-Warta valley connected with a similar valley of the pre-Odra that collected the waters of the pre-Prosna. In this way, an immense river was formed, running to the south and west of Berlin (cf. Text-fig. 1).

## SECTION PERWENITZ—VELTEN—SCHILDOW

The section (L—M in Text-figs 1 and 5) documents the Mazovian Interglacial to the north of Berlin. The sediments are represented by sands, overlain by lake silts with remnants of malacofauna of the so-called Paludina Bed (*Berliner Paludinenschichten*). They are up to 40 m thick and fill an erosive cutting with a distinct edge in the west. This incision is considered for a river valley, predisposed by depressions in the sub-Quaternary substrate, occupied partly by limnoglacial and glacial sediments of the Elstera II Glaciation (Sanian). The valley bottom of the Mazovian Interglacial time occurs there at about 40 m. b.s.l. whereas the valley is covered by fluvioglacial sands and tills of the Saale 1—2 Glaciation (Odranian) and the Saale 3 Glaciation (Wartanian), overlain by fluvioglacial and glacial sediments of the Weichsel Glaciation (Vistulian).

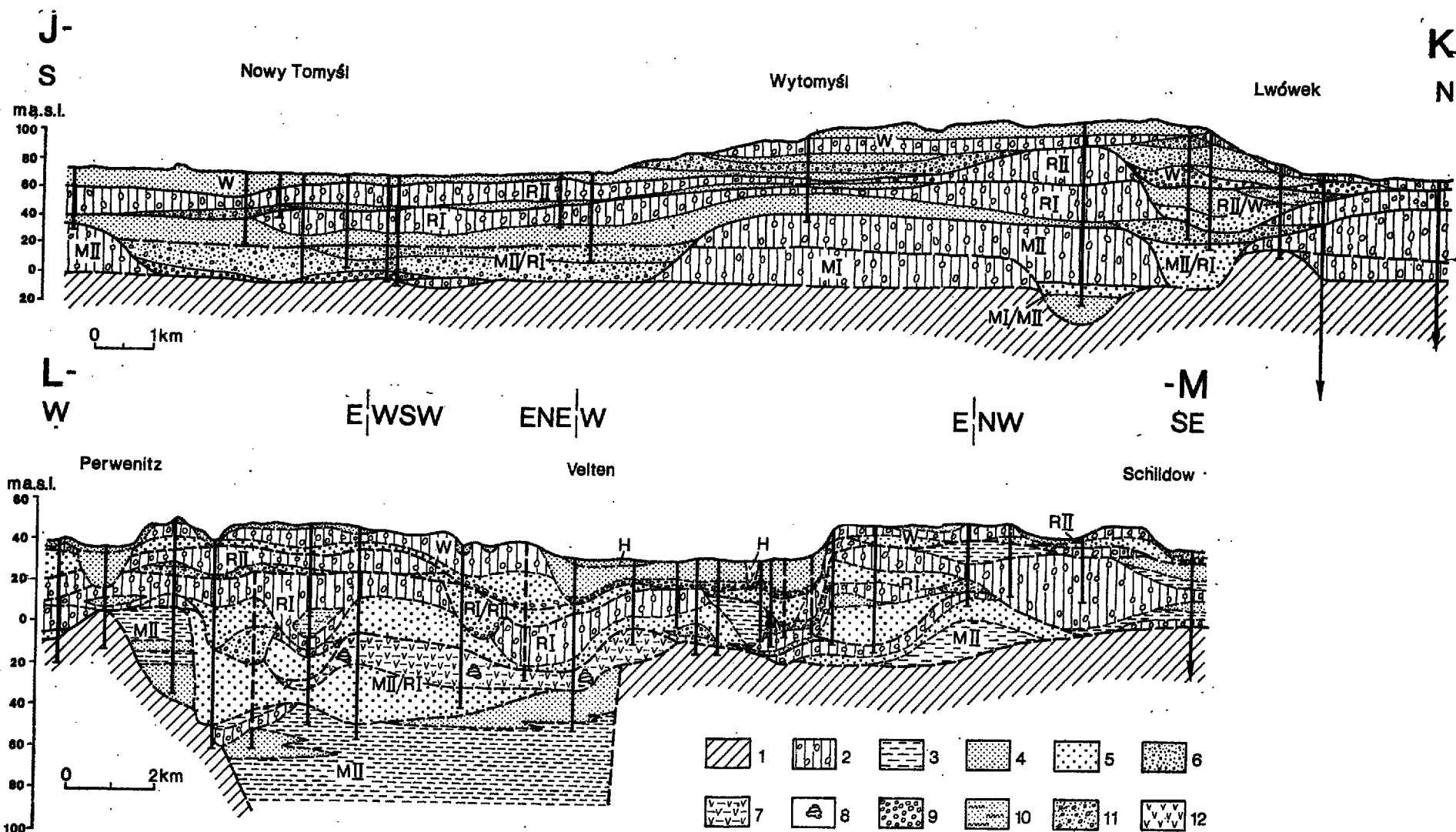
The valley was found to be the lower reach of the interglacial pre-Noteć valley, coming here from the southern Pomerania (Maksiak & Mróz 1978, Kozłowska 1976, 1979). The north-western Pomerania (cf. Kopczyńska-Zandarska 1970) and the north-eastern part of the Meklenburg Lakeland (cf. Cepek 1970) were drained at that time by the rivers entering the bay of the Holstein Sea; the latter occupied at that time the island of Uznam (cf. Text-fig. 1).

## SECTION KAROWER PLATE—VIESEN

The section (N—O in Text-figs 1 and 6) documents the sediments of the Mazovian Interglacial to the west of Berlin. These sediments are represented by sands, cut into a limnoglacial series of the Elstera II Glaciation (Sanian) and into the underlying pre-Quaternary deposits. The bottom of this incision reaches 50 m b.s.l. and is filled with interglacial fluvial sediments over 30 m thick, overlain by limnoglacial, fluvioglacial and glacial series of the Saale 1—2 Glaciation (Odranian) and the Saale 3 Glaciation (Wartanian) as well as by deposits of the Weichsel Glaciation (Vistulian).



Geologic sections Nowy Tomysł-Wytomyśl-Lwówek (after Dąbrowski 1981) and Perwenitz-Velten-Schildow (after Zwirner in: Cepek & al. 1975).



LITHOLOGY: 1 Quaternary substrate, 2 tills, 3 silts and clays (locally varved), 4 fine-grained sands, 5 coarse-grained sands, 6 vari-grained sands, 7 silts with clayey interbeddings, 8 malacofaunistic remains, 9 gravels, 10 silty sands, 11 sands with gravel, 12 muds

STRATIGRAPHY: MI — Nidanian Glaciation (Elstera I), MII/MII — Malopolanian (Voigstedt) Interglacial, MII — Sanian Glaciation (Elstera II), MII/RI — Mazovian (Holstein) Interglacial, RI — Odranian Glaciation (Saale 1—2), RI/RII — Lublin (Rügen) Interglacial, RII — Wartanian Glaciation (Saale 3), RII/W — Eemian Interglacial, W — Vistulian (Weichsel) Glaciation, H — Holocene

The sedimentary series that represent there the pre-Warta/Odra valley infilling of the Mazovian Interglacial time, are noted to the north-west (cf. Text-fig. 1) towards the Holstein Sea bay, occupying the present Lower Elbe valley (Cepek 1967, Erd 1973, Zagwijn 1979).

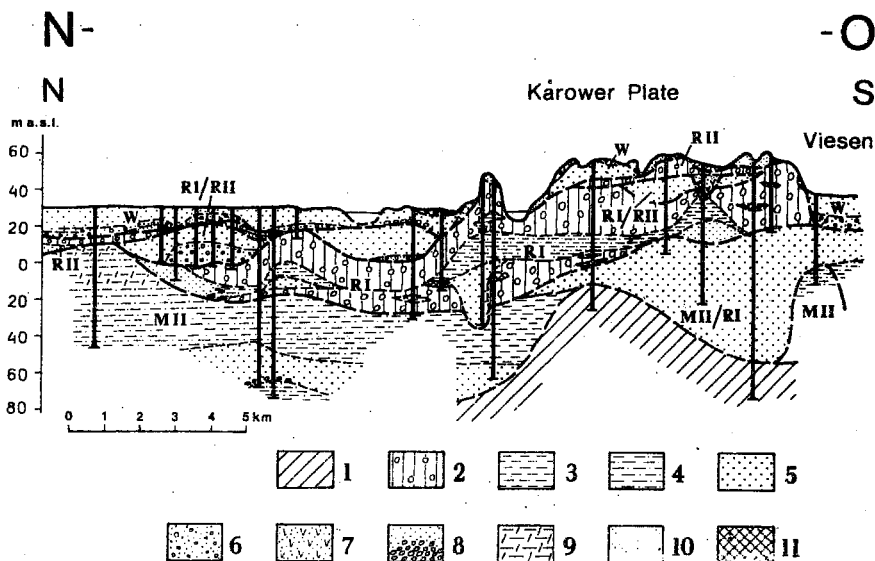


Fig. 6. Geologic section Karower Plate-Viesen (after Ziermann in: Cepek & al. 1975)

LITHOLOGY: 1 Quaternary substrate, 2 tills, 3 silts, 4 sandy silts, 5 medium-grained sands, 6 coarse-grained sands, 7 silty sands, 8 gravels and sands, 9 clayey silts, 10 fine-grained sands, 11 erratic lenses of Quaternary deposits

STRATIGRAPHY: **MII** — Sanian Glaciation (Elstera II), **MII/RI** — Mazovian (Holstein) Interglacial, **RI** — Odranian Glaciation (Saale 1—2), **RI/RII** — Lublin (Rügen) Interglacial, **RII** — Wartanian Glaciation (Saale 3), **W** — Vistulian (Weishsel) Glaciation

#### PALEOGEOGRAPHIC ANALYSIS

A paleogeographic analysis of main valleys of the Mazovian Interglacial (Mindel II/Riss I) enabled to group them into four principal drainage basins of the pre-Vistula, the pre-Neman, the pre-Warta/Odra, and the pre-Noteć (Text-fig. 7). Two former were drained into the Holstein Sea and the Sambia region (S in Text-fig. 1). Both other drainage basins were drained into the Holstein Sea bay that extended deeply into the Central European Lowland along the present Lower Elbe valley (E in Text-fig. 1).

Such valley system was formed mainly due to a specific deglaciation after the Sanian Glaciation, a retreat of which favored formation of parallel pradolina systems, used then by the interglacial rivers and intensive neotectonic processes of that time, acting at some tectonic structures of the Central European Lowland.

During the Mazovian Interglacial the pre-Vistula valley was located in its upper and middle reach in the axial section of the mobile (in Quaternary) Border Synclinorium that separated the Mid-Polish Anticlinorium (cf. Kutek & Głazek 1972) from the East European Platform, and it turns northwards only in its lower reach, being adapted to a meridional pattern of tectonic lineaments (cf. Ostaficzuk 1981). In the Warsaw area the valley used also the depressions between the folds of Pliocene clays (cf. Różycki 1972) whereas near Mochowo — the depressions of a glacial origin (cf. Lamparski 1981).

The pre-Neman valley was predisposed by tectonically mobile depressions and elevations at the marginal part of the East European Platform.

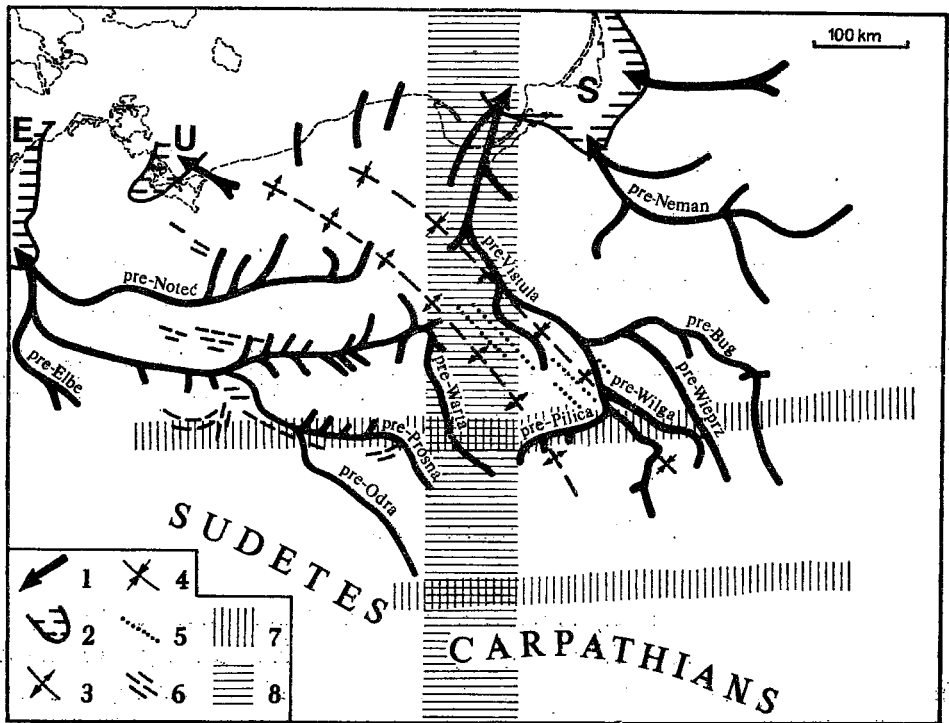


Fig. 7. Eastern Central Europe during the Mazovian (Holstein) Interglacial

1 river valleys; 2 sea bays (E — Elbe, U — Uznam, S — Sambia); 3 axis of Mid-Polish Anticlinorium; 4 axis of Border Synclinorium, 5 axes of folds in Miocene, Pliocene and Early Quaternary deposits (after Różycki 1972); 6 axes of main glaci-tectonic structures (after Dyjor 1975); 7 latitudinal tectonic megalineaments (after Ostaficzuk 1981); 8 meridional tectonic megalineament (after Ostaficzuk 1981)

The valley system of the pre-Warta/Odra and the pre-Noteć has been separated during the Mazovian Interglacial from the pre-Vistula drainage basin by a watershed corresponding greatly with the axis of the Mid-Polish Anticlinorium. Since a deglaciation after the Sanian Glaciation and during the earlier part of the Mazovian Interglacial, the anticlinorium subjected to an intensive uplift (Różycki 1972), defined (Baraniecka 1975, 1979) as the so-called Mazovian tectonic phase. The pre-Warta valley, located to the west of the Mid-Polish Anticlinorium, agrees considerably in its upper part with a meridional run of tectonic lineaments that favored the formation of the meridional reach of the Lower pre-Vistula valley (cf. Text-fig. 7). In the lower, parallel reach it corresponds with the Tertiary axis of the Wielkopolska Lowland, the dislocation zones of the Poznań Graben and halokinetic structures near Mogilno (Dąbrowski 1982). In turn, the valleys of the pre-Odra and the pre-Prosna correspond to dislocation zones within the Fore-Sudetic Monocline. During the Mazovian Interglacial these rivers, after being connected with the pre-Warta River, could not flow northwards for an occurrence of the Lubusz system of glaciotectionic elevations (Dyja 1975). This system separated the pre-Warta/Odra valley pattern from the pre-Noteć drainage basin further to the north.

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### **DOLINY INTERGLACJAŁU MAZOWIECKIEGO WE WSCHODNIEJ CZĘŚCI ŚRODKOWEJ EUROPY**

(Streszczenie)

Przedmiotem pracy jest analiza układu głównych dolin rzecznych z interglacjału mazowieckiego we wschodniej części Środkowej Europy (patrz fig. 1—7). Na układ tych dolin składały się dorzecza pra-Wisły i pra-Niemna uchodzących ku północy do zatoki morza holsztyńskiego obejmującego rejon Sambii, oraz dorzecza pra-Warty/Odry i pra-Noteci kierujących się ku zachodowi w stronę zatoki morza holsztyńskiego sięgającego na obszar dzisiejszej doliny Łaby. Rozwój takiego układu dolinnego podyktowany był przebiegiem struktur glacictektonicznych i sposobem zaniku lądolodu zlodowacenia Sanu (Mindel II), którego recesja sprzyjała formowaniu równoleżnikowych systemów pradolinnych wykorzystywanych następnie przez rzeki interglacjalne. Ważną rolę w kształtowaniu się interglacjalnej sieci rzecznej odgrywały ponadto ówczesne ruchy neotektoniczne.

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