

Lower Vistula River valley development after retreat of the last glaciation

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The Vistula River valley is a polygenetic landform. Its lower part beneath Bydgoszcz (to the north of Toruń-Eberswalde streamway) to the Żuławy (delta plain of the Vistula River) makes a large gorge through the ranges of moraine plains and recessional end moraines of Poznań and Pomerania phases. The present valley clearly resembles the lowering created before the Vistulian main stadial and its modern shape is mainly the result of glacial, fluvio-glacial, melt out and fluvial relief imposition.

Earlier originated depressions caused the modifications of the movement direction in the glacier sole. Its course in the nearest vicinity of the valley clearly indicates the connection with the arrangement of earlier existing relief. The tills coming into being were distinctly sandier than those from further plains. Gravel clasts shows clear enrichment in local rocks mainly glauconitic sandstones and Mesozoic limestones. The Vistula valley edges altered also the extent and the course of minor glacier oscillations (NIEWIAROWSKI 1959, DROZDOWSKI 1974).

During the glacier recession arose numerous small terminoglacial lakes but, differently to that in moraine plains, the varves were here not so well developed. Instead of sluggish deposition from suspension and from density and grain flows did more matter. The valley depression favoured the formation of dead ice blocks, hence the common existence of tiny kame terraces with debris flow sediments, ice-berg grounding structures and till dumps. In larger ice crevasses there were formed the sandy fillings landforms. The analysis of geomorphological conditions indicates that such a large ice blocks occurred behind the "shadows" of moraine uplands ledges.

The melt water flowing down from the glacier initially passed across the valley heading to south. After partial melting of blocking ice masses in the valley began the process of outwash, fluvio-glacial and fluvial terraces development. In southern part of the Lower Vistula River Valley, within the forefield of the Pomeranian phase there can be counted up to 11 such levels, in the northern part there exists only 8. The development of the terrace system was quick so that already on the onset of the Holocene the shape of the valley was very similar to the present one (BERGLUND & DROZDOWSKI 1976; KORDOWSKI 2013, 2014; KORDOWSKI et al. 2014).

At that time commonly occurred the vast valley lakes and mires, which left the thick layer of calcareous gyttjas. These sediments have covered up the Late Glacial fluvial braided structures present on the valley bottom, which is proved by investigations of topography beneath the present-day floodplain sediments cover. Ca. 3.400 years ago began the development of the flood sediments. At the beginning the sedimentation of those deposits resembled rather a lacustrine one. Afterwards, however, it has changed in favour of typical, fine, polymodal sediments. During the Little Ice Age come to extensive

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development of sandy ribbons (crevasse splays situated parallel to the river channel) due to increasing number of ice-jam floods in winter and spring seasons.

The analysis of sedimentological properties of the floodplain sediments indicates that the Vistula channel while its formation was fairly stable. The changes of river course were caused by increased frequency of floods due to winter ice jams. The analysis of biogenic sediments leads to the conclusion that they are overwhelmingly limnic. The development of the floodplain was also associated with shallow and vast lakes development. These features allow to assume, that the development of the initial stage of an anastomosing-like fluvial pattern in the present-day Vistula floodplain was recently interrupted by the human impact (river regulation). In the case of the lower Vistula region the anastomosing was most probably caused by the presence of many valley basins occurring over former valleys established prior the last glaciation (Vistulian main stadial) and gaps between them, where there were no valleys. They have been playing, to some point, an analogous role to mountains foredeeps, favouring the development of classical anastomosing (i.e. SMITH & SMITH 1980; RUST 1981).

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