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Original Research Article

VARIOUS GENETIC TYPES OF END MORAINES IN THE CITY OF POZNAŃ AND ITS CLOSE VICINITY, CENTRAL-WESTERN POLAND

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Abstract

The current research focuses on explaining the origin of end moraines running through the northernmost districts of the city of Poznań. The highest hills, that is, the Moraska Hill and the Dziewicza Hill, are a stagnation record of the Vistulian Glaciation of the Poznań Phase. These two hills represent terminal moraines of similar height and age, but the mechanism of their formation is diametrically opposed. The Dziewicza Hill is a typical accumulative end moraine, where Pleistocene deposits over 70 m thick are undisturbed. On the other hand, the Moraska Hill is a classic example of a push end moraine with a relatively thin cover of Pleistocene sediments and glaciotectonically elevated (up to 130 m a.s.l.) upper Neogene deposits. In the latter case, these strongly deformed sediments are the so-called "Poznań Clays" that underlie the Quaternary deposits in the vast area of the Polish Lowlands.

Keywords: accumulative and push end moraines, depositional and deformational processes, Scandinavian ice sheets, Pleistocene of central-western Poland

1. INTRODUCTION

The study area covers hilly territories with a west-east course. In fact, it is consistent with the extent of the marginal zone of the Poznań Phase of the last

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glaciation, that is, the Vistulian (Weichselian) glaciation (Fig. 1). Almost half of this area is within the administrative boundaries of Poznań, and half is in its close vicinity. The research area, in almost equal parts, is located on both banks of the Warta River, which flows longitudinally through Poznań City and crosses the above-mentioned marginal zone. As a result, the highest culminations (i.e., the Moraska and Dziewicza hills) belonging to the aforementioned end-moraine zone, are situated on the west and east banks of the Warta River, respectively (Fig. 1).

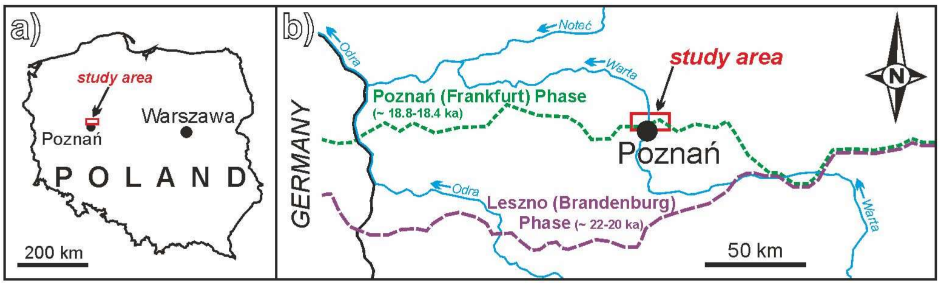

Fig. 1. Location map: a) study area in the background of Poland, b) study area against the background of the Leszno and Poznań phases of the Vistulian (Weichselian) Glaciation in central-western Poland [6, 8]

Both the Moraska Hill and the Dziewicza Hill have many similarities: age, morphology (height, slope inclination, etc.) and general glaciogenic origin. Nevertheless, their internal structure is significantly different. Therefore, the main aim of this study is to describe and then explain the mechanisms that led to the creation of these two types of end moraines of the same age and located in relatively close proximity to each other.
channel-fill sands and muds.

2. GEOLOGICAL AND GEOMORPHOLOGICAL SETTING

The study area is located in a very interesting geological as well as geomorphological position. Therefore, geology and geomorphology will first be briefly described, and then the issues of the impact of tectonics sensu stricto on the formation of modern morphology in the vicinity of the northern districts of Poznań will be identified.

2.1. Outline of geology

The research area belongs to two main structural-tectonic units of Poland, that is, to the Szczecin-Miechów Synclinorium and the Fore-Sudetic Monocline (Fig. 2a, b). In the previous case, where the Mesozoic top is made up of

Cretaceous rocks, the Miechów Synclinorium is divided into the Szczecin-Gorzów and Mogilno-Łódź segments [20]. However, most inspiring is the fact that three important fault zones connect just north of the Moraska and Dziewicza hills: Poznań-Szamotuły, Poznań-Oleśnica and Poznań-Kalisz fault zones (Fig. 2b) [3–5, 15–18].

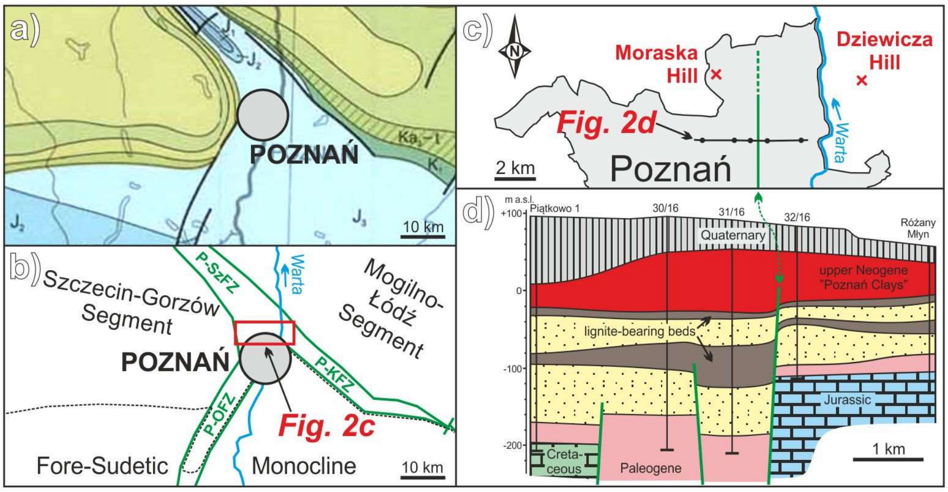

Fig. 2. Geological location of the study area: a) stratigraphy of the sub-Cenozoic surface [3], b) major tectonic units and structures: P-SzFZ – Poznań-Szamotuły Fault Zone, P-OFZ – Poznań-Oleśnica Fault, P-KFZ – Poznań-Kalisz Fault Zone [3–5, 15–18, 20], c), location of the cross-section depicted in Fig. 2d, d) generalised Cenozoic geology of the area between the Moraska and Dziewicza hills [12]; for location of the cross-section line see Fig. 2c

In the territory between the two hills, on the left bank of the Warta River and almost parallel to it, runs the eastern graben-bounding fault (or fault zone) of the Poznań-Oleśnica Fault Zone (Fig. 2c, d). Its vertical throw reaches over 175 m [12], along which Mesozoic as well as Paleogene and Neogene rocks are displaced. To achieve the aims of this paper, the youngest Neogene deposits, the so-called "Poznań Clays," are the most important. In the area under study, they have an average thickness of 30–70 m (Fig. 2d), and often comprise relatively thick (up to 35 m) sandy bodies, which are interpreted as fillings of fluvial palaeochannels [9, 14].

2.2. Outline of geomorphology

The Moraska and Dziewicza hills are high ca. 154 and 143 m a.s.l., respectively. They are surrounded by ground moraine and sandurs, which are at an altitude of 80–100 m a.s.l. (Fig. 3) [7, 19]. Thus, their relative heights in relation to the surrounding areas are up to 50 m (Fig. 4).

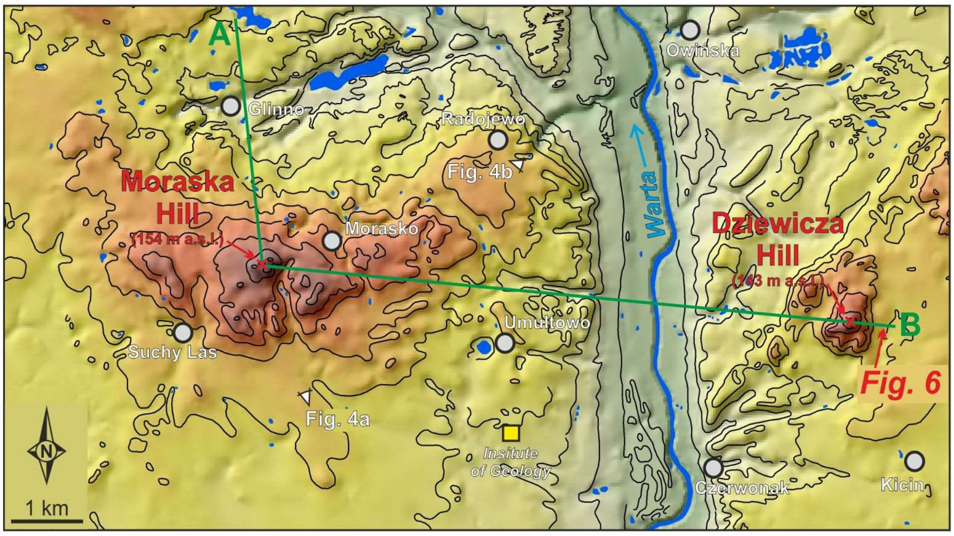

Fig. 3. Digital elevation model (DEM) of the Moraska and Dziewicza hills (prepared by W. Włodarski for [13])

The study area is cut longitudinally by the Warta River, which separates the Moraska and Dziewicza hills. Here, the Warta River creates a gap section that is called the Poznań Warta Gap [1, 2, 18]. Between the examined hills, the river is ca. 1.5–2 km wide, while its bottom is at an altitude of ca. 50 m a.s.l. Due to the fact that the Dziewicza Hill is 2 km away from the Warta River, and the Moraska Hill is more than 5 km, Dziewica is more visible (Fig. 4).

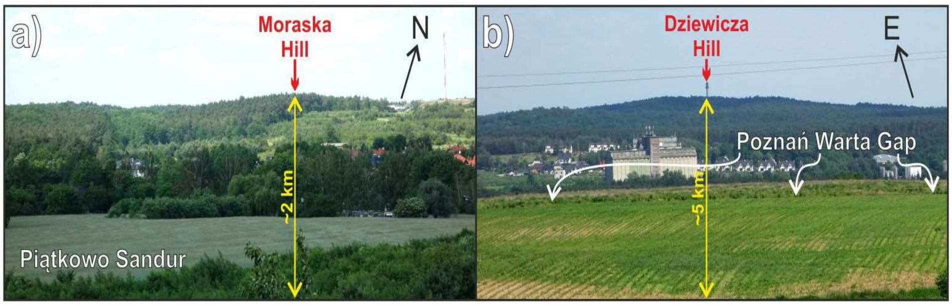

Fig. 4. Broad view of the studied forms: a) northward view of the Moraska Hill, b) eastward view of the Dziewicza Hill

3. DATA AND METHODS

The stratigraphy of the Vistulian (Weichselian) deposits is based on data from geological maps and explanations to them [2, 8, 10, 11]. Figures 5 and 6 are prepared on materials (mainly boreholes) that originally come from the National Geological Archive and Central Geological Database of the Polish Geological Institute – National Research Institute in Warsaw, Poland.

However, the most important research method used in this work to explain the origin of different types of end moraine is the palaeomorphological analysis of the top of the "Poznań Clays" (Figs. 5, 6). These Mio-Pliocene fine-grained deposits are widely spread and relatively easy to identify both in boreholes and in the field [9].

4. STUDY RESULTS

The results obtained will be presented in a specific order. First, the geological structure of the Dziewicza Hill and then the Moraska Hill will be described and interpreted (Figs. 5, 6). Finally, new conceptual models for the creation of both studied hills will be proposed (Fig. 7).

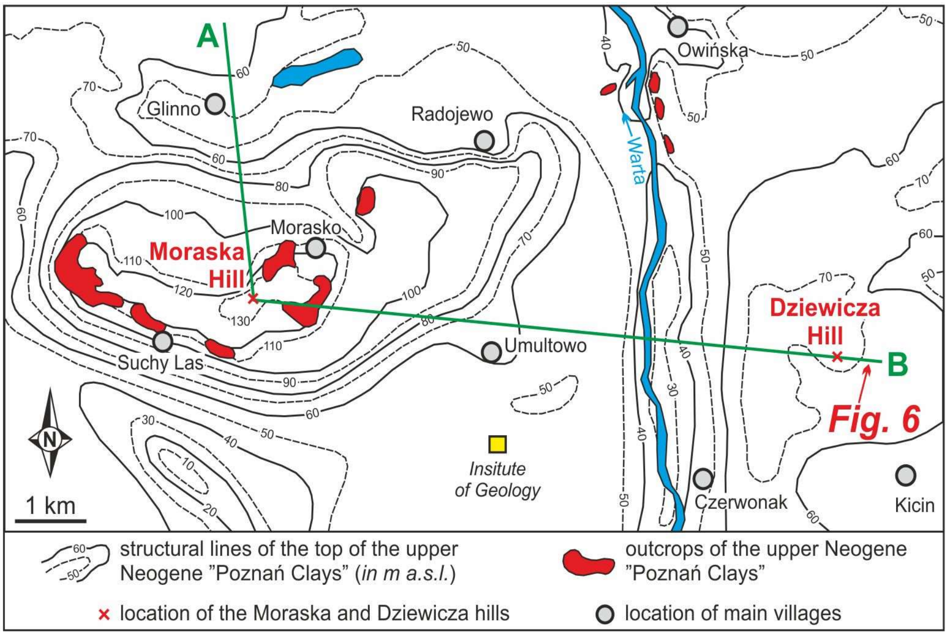

Fig. 5. Structural map of the top of the upper Neogene "Poznań Clays" [2, 13]

4.1. Dziewicza Hill – accumulative end moraine

Description. The Dziewicza Hill is located on the right bank of the Warta River. The Quaternary bedrock is built of the "Poznań Clays" that lie quite flat at a height of 60–70 m a.s.l. (Figs. 5, 6). Above are Quaternary deposits, mainly of Pleistocene age. They represent the following glaciations: Elsterian, Saalian and Weichselian (Vistulian). The vast majority of the Dziewicza Hill is made up of fluvioglacial sediments (sands and gravels), among which the Vistulian tills occur sporadically, creating thin lenses (Fig. 6).

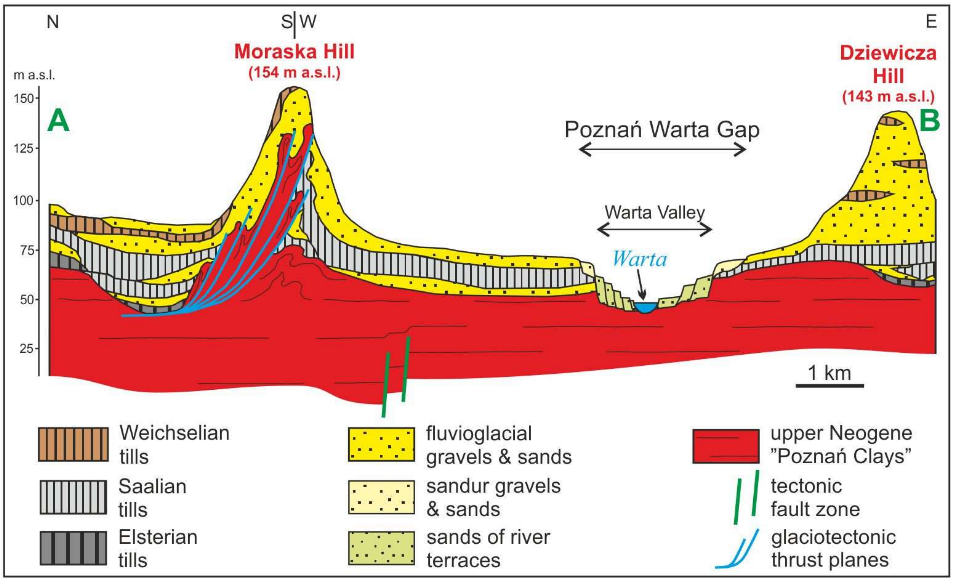

Fig. 6. Cross-section through the area between the Moraska and Dziewicza hills [10, 11, 13]; for location of the cross-section line A–B see Figs. 3, 5

Interpretation. Analysing the shape of the "Poznań Clays" top and the inner structure of the Dziewicza Hill, it can be stated that the sediments of the upper Neogene and Pleistocene have not been noticeably deformed syn- and/or post-depositionally. Therefore, the Dziewicza Hill should be considered as a typical accumulative end moraine. Most likely, it was created in front of the forehead of the stagnant (sub-)lobe of the Scandinavian ice sheet (Fig. 7a, d) [17].

4.2. Moraska Hill – push end moraine

Description. The Moraska Hill is located on the right bank of the Warta River. Generally, the same sediments as mentioned above are present in this case (Fig. 6). However, in contrast to the area of the Dziewicza Hill, both the Quaternary bedrock and the Pleistocene glaciogenic deposits are strongly deformed. This is particularly visible at high elevation in the "Poznań Clays" a height above 130 m a.s.l. (Figs. 5, 6). Obviously, tills of older glaciations, such as the Saalian glaciation, are also elevated near the surface (Fig. 6).

Interpretation. The formation of the Moraska Hill must be explained differently than the creation of the Dziewicza Hill. This is due to macroscale glaciotectonic deformations that have been documented in the area of the Moraska Hill (cf. Figs. 5 and 6). These deformations arose in the marginal zone by pushing the rock

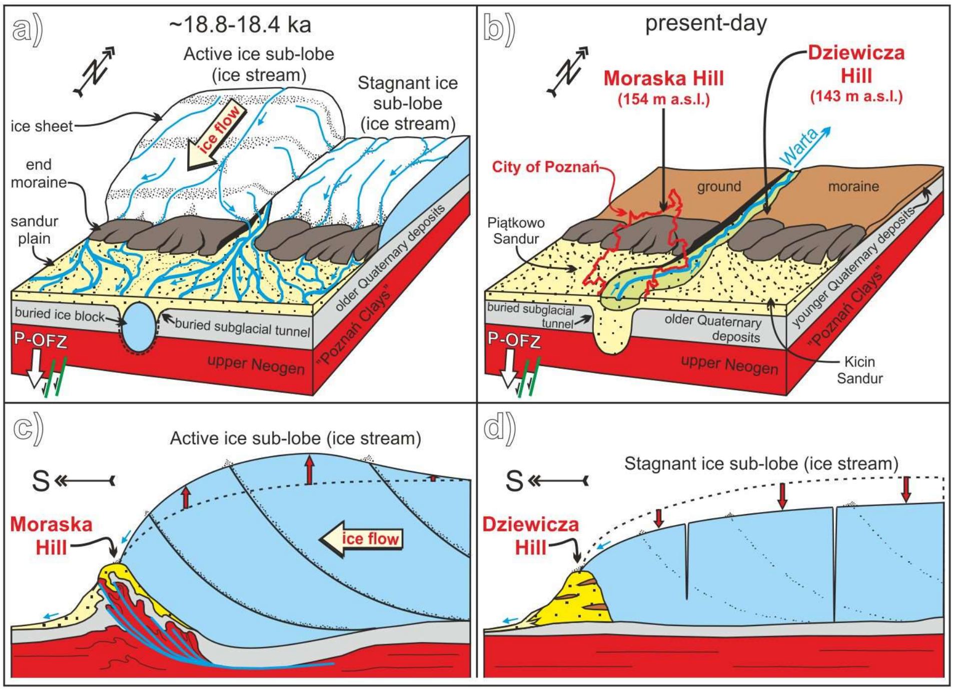

Fig. 7. Conceptual models depicting the formation of the push (Moraska Hill) and accumulative (Dziewicza Hill) end moraines: a) and b) blockdiagrams, c) and d) cross-sections [17]; for other explanations see Figs. 3, 5 and the text

material from under the ice sheet onto its foreland. In this case, the increase in vertical stress, caused by the weight of the ice column (i.e., glaciostatic pressure), has probably played the most important, destructive role. Such a situation is characteristic of an active (sub-)lobe, when new masses of ice flow into its marginal zone (Fig. 7a, c). As a result of the increasing thickness of the ice sheet, the stress on the substratum exceeded the strength of the disturbed basal deposits, predominantly the upper Neogene "Poznań Clays" (cf. Figs. 5, 6, 7c). In conclusion, the Moraska Hill is one of the best examples of a push end moraine in Poland [2, 6–8, 10, 11, 13, 17, 20].

5. FINAL REMARKS

The Dziewicza and Moraska hills are the highest hills in close vicinity of Poznań. They represent terminal moraines of the Poznań Phase of the Vistulian Glaciation. Furthermore they are characterised by similar height and age, but have opposite mechanisms of formation.

The Dziewicza Hill is widely recognised as an accumulative end moraine, while the Moraska Hill is unquestionably a push end moraine. The previous one probably came into being in front of the forehead of the stagnant (sub-)lobe. In contrast, the formation of the latter one is most likely associated with an active (sub-)lobe, whose increasing thickness in the marginal zone caused glaciotectonic uplift and deformation of older sediments, including the "Poznań Clays."

So far, the relationship between the bedrock geology and geomorphology has not been convincingly explained in the study area. In this case, it is the parallelism of the deeply-rooted fault zone and the Poznań Warta Gap (cf. Figs. 2, 6 and 7a, b). Thus, the solution of this interesting geological-geomorphological research problem will also contribute to the full explanation of the creation of the aforementioned Poznań Warta Gap between active and stagnant (sub-)lobes of the Scandinavian ice sheet.

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