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Results of paleomagnetic investigation on Permian rocks of the Hronic Unit (Western Carpathians, Slovak Republic)

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Abstract: The magnetostratigraphic investigation on the profile of the Upper Carboniferous-Permian rocks belonging to the Hronic Unit in the Nízke Tatry Mts. revealed occurrence of the first-order time marker, so called Illawara Reversal, near the boundary separating the 2nd and 3rd megacycles at localities of the Malužiná Fm.

Key words: Hronic multinappe Unit, Late Paleozoic magnetostratigraphy, Illawara Reversal

Introduction

The continental sequences of the Permian in the Western Carpathians are generally very poor in organic remnants determining insufficient radiometric data. The time period within the range of 300 – 250 Ma is prevailingly represented by clastic sediments and volcanics, which are preserved in the structure of Alpine units of the Western Carpathians in relics only. The analysis of these sequences has been carried out so far mainly by methods of lithostratigraphical analysis combined with biostratigraphical and isotope-geochronometrical methods. The objective of this paper is to put forward a more precise time scale of the Permian of the Hronic Unit by the method of magnetostratigraphy. The complete profile of Upper Carboniferous-Permian of the Hronic Unit in the Nízke Tatry Mts. was analysed by standard magnetostatigraphical methods. We choose localities in the Malužiná and Dikula Valleys (Fig. 1.) which consist of non-metamorphosed sedimentary complexes. At these complexes we assume preservation of primary remanent magnetic polarization. Moreover, these sequences are continuously preserved from the underlying Upper Carboniferous rocks to the overlying Lower Triassic rocks.

In Permian volcanic-sedimentary formations of the Western Carpathians the method of magnetostratigraphy has not been applied so far. In the preceding period the paleomagnetic investigation was carried out (the results published by Muška 1975-1988, Muška & Vozár 1987-1989, mainly in the frame of Project IGCP 5), but only used for the tectonic reconstructions. The amount of the data from individual lithostratigraphic units was not sufficient to be able to establish correlation with the magnetostratigraphic scale.

Geological setting

Late Palaeozoic volcano-sedimentary complexes in basal part of nappes of the Hronic Unit are denoted as the Ipoltica Group which consists of Nižná Boca and Malužiná Formations (Vozárová & Vozár, 1981). The tectonic basement of the Ipoltica Group, located in the Ipoltica and Dikula Valleys S of the Čierny Váh river on the northern slopes of the Nízke Tatry Mts., consists of the Veporic Unit, mostly of the Mesozoic of the Veľký Bok Group. The internal structure of the Ipoltica Group sequences is affected by the Alpine thrusting and faulting processes. Variable tectonic reduction is evident mainly in the sedimentary sequences of the Nižná Boca Formation.

Brief characteristics of lithostratigraphic units

Nižná Boca Formation. It is generally coarsening-upward siliciclastic sequence consisting of numerous small, repeating fining-upward sedimentary cycles. The vertical profile of the Nižná Boca Fm. indicates channel and overbank fluvial deposits originated in meandering rivers. The presence of lacustrine deposits suggests occurrence of lakes nearby rivers. The deposits are predominantly Gray and black. This fluvial-lacustrine and/or fluvial-deltaic and lacustrine association was interrupted by synsedimentary subaerial volcanism. It is manifested by abundant redeposited volcanogenic material mixed with non-volcanic detritus and with sporadic occurrences of thin layered dacitic tuffs as well as exceptionally dacite lava flows.

Macroflora from the uppermost part of the Nižná Boca Fm. proved the Stephanian B-C age (Sitár & Vozár, 1973). The palynological analysis of Planderová (1973) distinguished the Stephanian A-B and the Stephanian C-D microflora assemblages.

Malužiná Formation. The Permian sequence of the Malužiná Fm. is developed gradually from the underlying Nižná Boca Fm. It comprises a thick succession of redbeds (more then 2000 m in places) which consists of alternating conglomerates, sandstones and shales. Lenses of dolomites, gypsum and calcrete/caliche horizons occur locally. Fining-upward cycles in the order of several me-

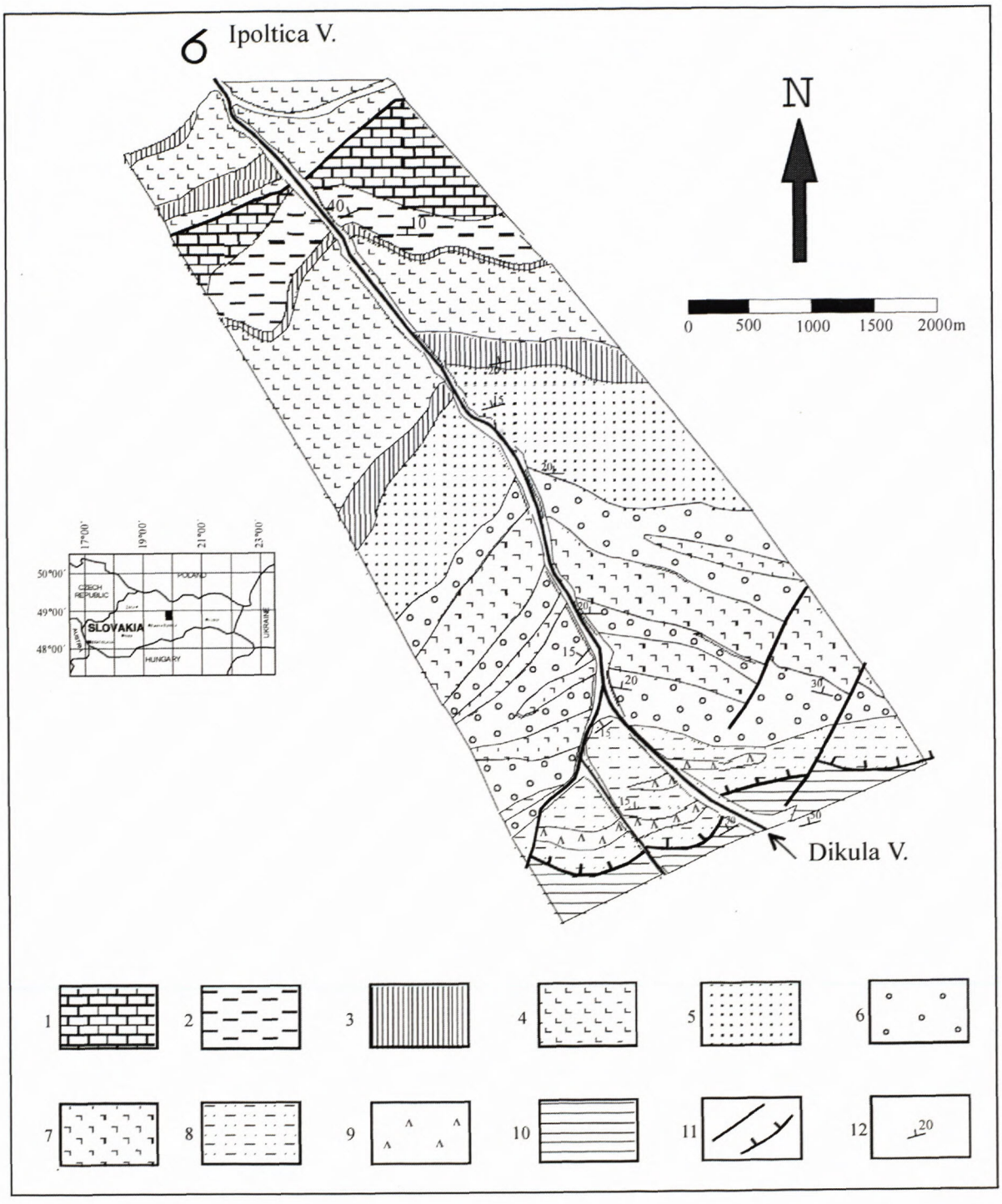

Fig. 1 Geological situation of the Ipoltica V. and Dikula V. (Northern part of the Nízke Tatry Mts.)
Explanation: Hronic Unit –1. carbonate rock complex of Middle Triassic; 2. clastic sediments of Lower Triassic; 3 – 7. Malužiná Formation: 3. 3rd megacycle sediments; 4. andesite-basalts of 2nd eruption phase; 5. 2nd megacycle sediments; 6. 1st megacycle sediments; 7. andesite-basalts of 1st eruption phase; 8 – 9. Nižná Boca Formation: 8. sediments; 9. dioritic sills and dykes of Permian in age; Veporic Unit – 10. Mesozoic sediments of the Veľký Bok sequence; general explanation: 11. faults; overthrust lines, 12. schistosity, foliation

ters, as well as three regional megacycles arranged above each other, are typical. The polyphase synsedimentary andesite-basalt volcanism is the further significant phenomenon. Fossil remnants of the channel bar and point bar deposits associated with flood plain and natural levee sequences are dominant in the lower part of the three megacycles. A playa and inland sabkha/ephemeral lake association was identified in the upper part of the megacycles. The deposits of the Malužiná Fm. were deposited mainly in fluvial and fluvial-lacustrine depositional system during permanent semiarid and arid climate.

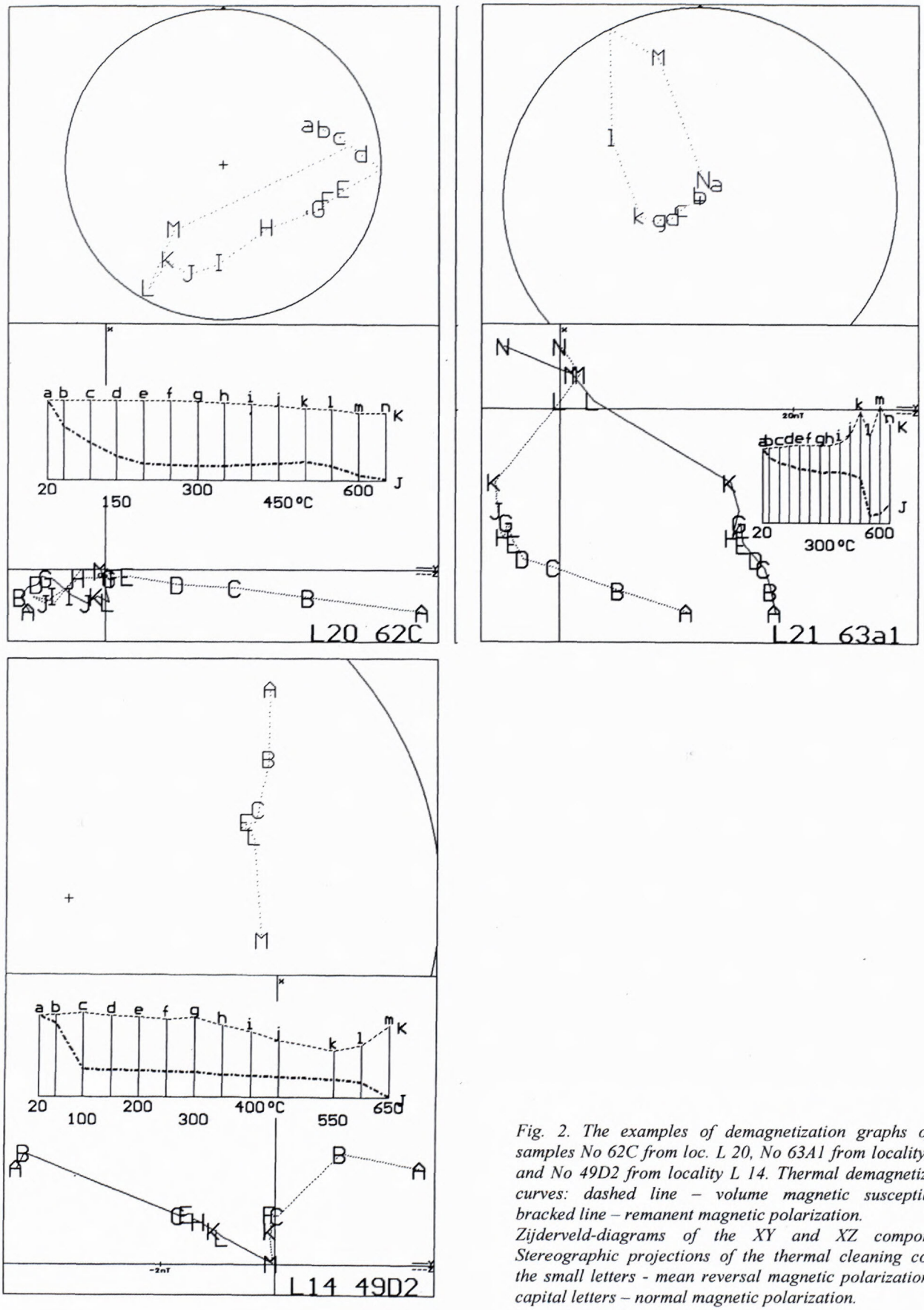

Fig. 2. The examples of demagnetization graphs of the samples No 62C from loc. L 20, No 63A1 from locality L 21 and No 49D2 from locality L 14. Thermal demagnetization curves: dashed line – volume magnetic susceptibility; bracked line – remanent magnetic polarization.
Zijderveld-diagrams of the XY and XZ components. Stereographic projections of the thermal cleaning course: the small letters - mean reversal magnetic polarization; the capital letters – normal magnetic polarization.

The microflora proved the Lower and Upper Permian age of the Malužiná Fm. The following assemblages were described by Planderová (in Planderová 1973 and Planderová & Vozárová, 1982): 1. The Autunian assemblage, corresponding approx. to the sediments of the 1st megacycle; 2. The Autunian-Saxonian assemblage, specifying age of the 2nd megacycle; 3. The Thuringian assemblage, determining age of the third megacycle sediments.

In the upper part of the 2nd megacycle a local lithostratigraphic member was defined – the Kravany Beds. They consists of gray and greenish-gray sandstones and siltstones with locally redeposited plant debris and thin uranium-bearing horizons. The Autunian-Saxonian microflora assemblages correspond approximately to the 1st and 2nd megacycles. This assumption is supported by $^{206}Pb/^{238}U$ and $^{207}Pb/^{235}U$ dating of 236 and 274 Ma from uranium-bearing layers (Lepka in Rojkovič et al. 1992).

Magnetostratigraphic measurements

The 351 rock samples from 23 outcrops of investigated profile were elaborated. Each sample was undergone thermal magnetic cleaning. Paleomagnetic measurements were carried out in Paleomagnetic laboratory of the Geophysical Institute SAS Bratislava. The demagnetization step of 50 °C from the natural stage till to 650 °C was used. The remanent magnetic polarization as well as volume magnetic susceptibility were measured after each demagnetization step. Thermal cleaning was performed into MAVACS – system, magnetic polarization was measured on spinner magnetometer JR-5 and volume magnetic susceptibility on cappa-bridge KLY-3. The demagnetization graphs, so called Zijderveld-diagrams of XY and XZ components and stereographic projection of the remanent magnetization vectors was performed. Mean paleodirection of each locality (outcrops) was calculated using the Fisher statistics (Fischer, 1953).

Characteristic paleodirection of measured sample was chosen according to demagnetization graphs (Fig. 2). The smooth part of the magnetic susceptibility curve indicated that no phase transition of magnetic mineral occurred in rock sample. We supposed that after several first thermal steps the secondary, probably viscose, magnetic polarization was released. Convergention of the paleodirections on stereoprojection as well as on Zijderveld-diagrams was also criterion for choosing of characteristic direction. Several samples with the large dispersion of the remanence directions were rejected.

In efforts to choose as probable as possible paleodirection we analysed the four variants of characteristic directions.

Discussion and conclusion

The results are summarized in a schematic magnetostratigraphic profile for the Late Palaeozoic of the Hronic Unit (Fig. 3). In the Upper Carboniferous, the reversal pattern has been extended into the whole profile in the Dikula Valley. The mean values of magnetic inclination is ranging from –30° to –40°. The set of measured samples from both Upper Carboniferous localities is characterized by reversely and homogeneously magnetized rocks. Indication of normal polarity were found close to the Nižná Boca Fm./ Malužiná Fm. boundary (loc. NT-3). Within the 1st and 2nd megacycles of the Malužiná Fm. sediments both normal and reversal magnetization have been found besides some inhomogeneous samples. Prevalent part of sediments is characterized by reversal polarity with the mean inclination between 0° and -30°. Several normal magnetized horizons were found. The mean positive inclination within the 1st and 2nd megacycles varies between 0° and +45°.

We assume, despite of this uncertainty, that the sediments of the Nižná Boca Fm. and the 1st and 2nd megacycles of the Malužiná Fm. belong to the Carboniferous-Permian Reversed Megazone (Menning, 1995; formerly the Kiaman Magnetic Interval - Irwing & Parry, 1963, later abandoned by Irwing and Pullaiah 1976 and replaced by the Permo-Carboniferous Reversed Superchrone). Within the Carboniferous-Permian Reversed Megazone (CPRM) were described several normal zones (according to Menning, l.c. at least five horizons). Two were identified near the Carboniferous-Permian boundary of the Transcaucasus succession (296 Ma; Khramov & Davydov, 1991). Two further normal zones are in the volcanics of Tholey Subgroup of the Saar-Nahe-Basin (291 Ma; Berthold et al., 1975). A fifth normal zone is in the Garber Sandstone (Oklahoma, about 280 Ma; Peterson & Nairn, 1971). Nevertheless, correlation of the Malužiná Fm. normal zones with those five zones is complicated due to absence of any radiometric dating.

There is evidence that in the uppermost part of the 2nd megacycle (Fig.3) a systematic change of the inclination occurs. A strong change in the inclination occurs at loc. NT-14 (Fig. 3). The mean value of inclination is shifting from +80 to negative inclination. This zone could be correlated with Illawara Reversal (IR). This assumption is supported by the radiometric data 263 resp. 274 Ma from the lithostratigraphical equivalent uranium-bearing horizon. IR is a first-order time marker estimated by Khramov (1963) within the Tatarian. According to Menning (1995) the age of the Illawara Reversal is 265 Ma.

Within the third megacycle of the Malužiná Fm. there are alternating reversed and normal polarity zones. They should be correlated with The Permian-Triassic Mixed Megazone Menning (1995).

The following facts underline the reliability of the results:

1. The magnetostratigraphic boundary represented by a strong change of polarity fall within lithological units.

2. The polarity determination in the whole complex of collected sediments is complicated. Additional

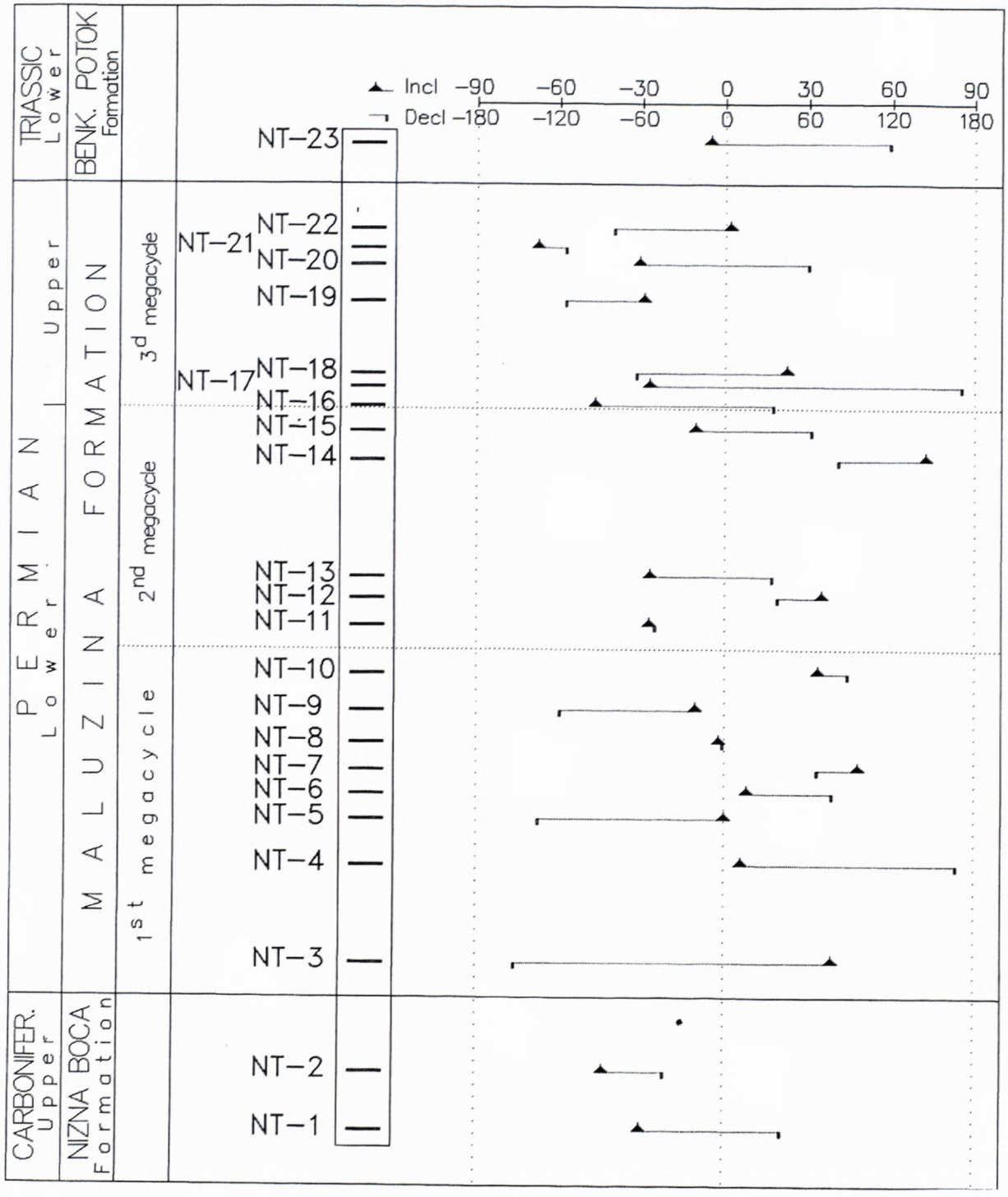

Fig. 3. Results of magnetostratigraphic investigation of the Late Palaeozoic Hronic Unit. Explanation: NT no – number of locality (outcrops); full triangle – mean magnetic inclination; perpendicular short line – mean magnetic declination.

investigations must be carried out using finer grained samples as far as possible and applying a detailed thermal ev. alternating field demagnetization.

3. The Autunian-Saxonian sequences are divided from the Thuringian of the Malužiná Fm. by strong change of polarity confirming by the Illawara Reversal.

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