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Results of the preliminary paleomagnetic investigations of some Lower Paleozoic rocks from the Holy Cross Mts (Poland)*

Preliminary paleomagnetic data from the south-western part of the Holy Cross Mts (Poland) are presented. Paleomagnetic directions, obtained from the Lower Cambrian (declination = 340°, inclination = 78°), the Lower Ordovician (D = 198°, I = 74°) and the Upper Silurian (D = 218°, I = 7° or, alternatively, D = 229°, I = 27°) sandstones and greywackes, being compared with coeval paleomagnetic data from the East-European Platform implies 4000 km separation of both regions in the Cambrian – Lower Ordovician time and their final joining in the Upper Silurian. Paleolatitude similarity of the area under study to the Armorica Plate in the Lower Paleozoic is also suggested.

INTRODUCTION

Early Paleozoic paleogeographic reconstruction in the zone of the contact of the East-European Platform (EEP) and its south-western forefield is a matter of a long-lasting dispute. Two essential interpretations of the observed contrast in the facial development of these two geotectonic units, could by recently distinguished, namely:

– classical fold-nappe approach, explaining close contact of the differently developed coeval series due to tectonic shortening of the Early Paleozoic geosyncline (W. Pożaryski, 1977; Z. Modliński, 1981);

– mobilistic interpretations, which assume either straight or oblique collision of microplates with Baltica (P.A. Ziegler, 1982) or strike-slip displacement, being operated in Early Paleozoic time (W. Brochwicz-Lewiński et al., 1981; see also R. Dadlez, 1983; J. Znosko, 1983 for critical review).

No paleomagnetic data from Poland have been available so far to confirm or deny whichever of the presented hypothesis. This paper, aiming to support the

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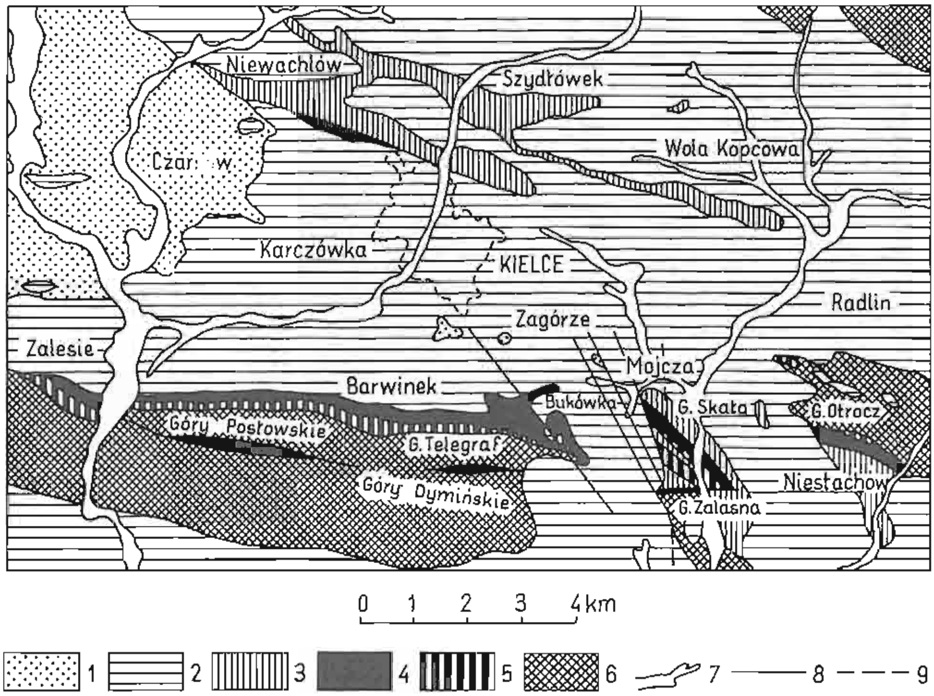

Fig. 1. Geological sketch map of the Kielce syncline (after H. Tomczyk, 1956)

Szkic geologiczny synkliny kieleckiej (wg H. Tomczyka, 1956)

1 – Mesozoic; 2 – Upper Paleozoic; 3, 4 – Silurian; 5 – Ordovician; 6 – Cambrian; 7 – aluvium; 8 – faults; 9 – border of Kielce Town

1 – mezozoik; 2 – górny paleozoik; 3, 4 – sylur; 5 – ordowik; 6 – kambr; 7 – aluwia; 8 – uskoki; 9 – granice miasta

discussion by supplementary, new data, provides preliminary paleomagnetic results from the Early Paleozoic sedimentary rocks of the Holy Cross Mts (HCM; approx. latitude = 50°50′N, longitude = 20°20′E). For details, supplemented by more comprehensive paleogeographic considerations reader is kindly referred to the forthcoming issues of the Physics of the Earth and Planetary Interior.

As one proceeds with testing of the above interpretations one has to bear in mind the fact that classical model implies lack of the paleolatitude difference between EEP from the one side and its recent forefield from the other. Mobilistic models accept the presence of such a difference in some favourable circumstances, i.e. when a vector of a relative movement of the two plates was at least oblique (preferably perpendicular) to the paleolatitudes in the time under consideration (cf. R. van der Voo, 1983). In the case of movements parallel to the paleolatitude paleomagnetic data alone are not enough powerful tool for distinction between displaced and not displaced terrains, as paleolatitude difference is absent in both instances.

From geological point of view, HCM area can be divided into two subregions, namely: southern and northern, which are brought together along Łysogóry overthrust. Paleomagnetic sampling has been made in the southern region, about 10 km to the SE from Kielce Town, in the vicinity of Mójcza village (Fig. 1).

In the area under investigation Early Paleozoic rocks are represented by the Lower Cambrian quartzites, folded and slightly metamorphosed during the Middle/ /Upper Cambrian orogeny (Świętokrzyska phase, see H. Tomczyk, 1974). They are discordantly overlaid by the Lower Ordovician unmetamorphosed sandstones (W. Bednarczyk, 1967) and, subsequently, the Middle Ordovician limestones (the latter not investigated in this study).

The top parts of the stratigraphical sequence are the Upper Silurian greywackes, being a synorogenic deposit of the Ardenian phase (J. Znosko, 1986). Both Ordovician and Silurian rocks were folded due to lateral compression at the final stage of the Caledonian orogeny (H. Tomczyk, 1974) and, subsequently, unconformably covered by the Lower Devonian deposits.

FIELD AND LABORATORY METHODS

A total of 64 oriented hand samples have been collected from the five (two Cambrian, two Ordovician and one Silurian) main outcrops. Magnetic compass has been used for sample orientation with measurements error ±2° (magnetic declination in Kielce region is 2°). Each hand sample has been cut into several cylindrical specimen by means of 22 mm diamond drill bit. In order to remove secondary magnetization, each specimen has been subjected to the thermal demagnetization experiment, carried out in non-magnetic furnace with residual magnetic field inside as low as $1 \cdot 10^{-5}$ A/m. Natural remanent magnetization (NRM) have been measured after each demagnetization step by means of JR-4 spinner magnetometer. Essentially, the increasing of the cleaning temperature proceeded so long as either intensity of the NRM dropped down to the apparatus noise level (i.e. $3 \cdot 10^{-6}$ A/m) or spurious signal, introduced by mineralogical changes, did not allow for further investigations. In the case of a multicomponent nature of the NRM, its components have been extracted by subtracted vector analysis (K. Hoffman, R. Day, 1978). For statistical calculations, computer program by J.L. Kirschvink (1980) has been used. Line fit has been accepted as representative for NRM component if max. angular standard deviation has been less then 15° (see J.L. Kirschvink, 1980). Fold test (M.W. McElhinny, 1973) has been applied to the Cambrian and Ordovician rocks to determine time relationship between acquisition of the remanence and folding of the strata. As usually in paleomagnetic analysis, no preference (except of the Upper Silurian rocks) was given to the stronger remanence and characteristic directions were averaged out assuming their unit lenght (cf. M.W. McElhinny, 1973).

MAGNETIC CARRIERS

To determine remanence carriers thermomagnetic analysis and optical petrography have been used. In the Lower Cambrian rocks hematite is the principal magnetic mineral. Its origin can be referred to the oxidation of unrecognized, opaque minerals, which are observed in thin sections. The Lower Ordovician and Upper Silurian sandstones contain magnetite grains, responsible for more stable NRM component. The most viscous remanence of recent origin resides in goethite, documented in all investigated formations.

PALEOMAGNETIC RESULTS

LOWER CAMBRIAN

Lower Cambrian rocks were sampled at the Zalasna and Otrocz hills, situated around 2.5 km apart (Fig. 1). The rocks are exposed at the juxtaposed limbs of the local syncline, dipping to the NNE (Zalasna) and SSE (Otrocz) at the angle of 75 and 40°, respectively.

Paleomagnetic record of the investigated rocks is very simple. Initial NRM vectors of intensities as high as $2 \cdot 10^{-2}$ A/m are groupped well (Fig. 2a) near to the present ($D = 2°$, $I = 66°$) geomagnetic field direction and during thermal demagnetization up to 685°C all vectors display linear decay to the origin. According to the paleomagnetic theory, such behavior of the NRM testifies univectorial nature of the remanence. The less dispersion of the NRM occurs after

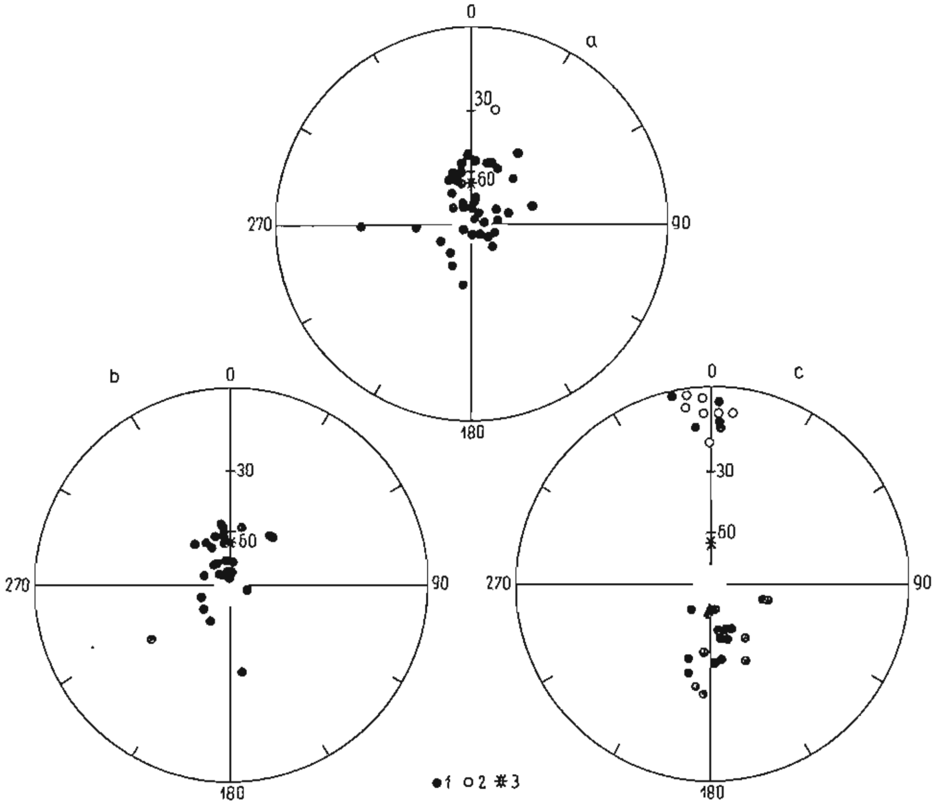

Fig. 2. Initial NRM for specimens of Lower Cambrian (a) and distribution of the vectors after demagnetization at the 500°C level before (b) and after (c) bedding correction

Początkowe kierunki NRM dla próbek dolnego kambru (a) oraz wektory po rozmagnesowaniu w temperaturze 500°C w układzie przed (b) i po (c) korekcji na upad warstw

1 – NRM vector directed downward; 2 – NRM vector directed upward; 3 – present-day field direction; equal-area projection

1 – wektor NRM skierowany w dół; 2 – wektor NRM skierowany w górę; 3 – współczesny kierunek pola geomagnetycznego w Kielcach; projekcja równopolowa normalna Lamberta

Table 1

Characteristic NRM and corresponding paleopole positions for the Lower Cambrian rocks from vicinity of Mójcza village (Otrocz, Zalasna)

	Before bedding correction				After bedding correction			
	D	*I*	alfa 95	*k*	*D*	*I*	alfa 95	*k*
Best groupping temp. level = 500°C *n* = 35, *N* = 15	340°	78°	6.54°	14.7°	79°	85°	23.18°	2.06°
Paleopole position	lat. = 71°N, long. = 356°E				lat. = 60°N, long. = 38°E			
Paleolatitude	66°S				not considered			

D – declination, *I* – inclination, alfa 95 – semi-angle of the conus of confidence, *k* – fisherian precision parameter (M.W. McElhinny, 1973), lat. – latitude, long. – longitude, *n* – number of specimen, *N* – number of independently orientated hand samples

heating in 500°C and, as superimposed vectors are lacking, mean direction obtained at this temperature level can be tentatively regarded characteristic (Table 1).

The NRM vectors cluster significantly better before tectonic correction (fold test negative), implying post-folding, secondary origin of the NRM (Fig. 2b, c). Six (from 23) specimens of Zalasna Hill are reversely magnetized on the level of 500°C. After thermal cleaning, the overal characteristic mean is placed westward to the mean of the initial NRM and is significantly different from the present-day direction at the 95% probability level. The older expected direction is compared (see M. Lewandowski, 1983 for reference direction path), the difference between it and obtained mean become more distinct, thus none expected direction can be regarded similar.

Since both the post-Caledonian (M. Lewandowski, 1983) rocks, and the overlying Lower Ordovician and Upper Silurian sandstones (this study) show drastically different image in direction, intensity and homogeneity of the NRM record, the remagnetization phenomena should be referred to the weak metamorphism and flexural folding of the pre-Ordovician tectonic phase. Mixed polarity observed in Zalasna rocks additionally supports the fact of ancient origin of the NRM. Very good groupping of the remanence directions implies that the Late Caledonian orogeny did not influenced the geometry of the Early Caledonian fold structures on the investigated area.

LOWER ORDOVICIAN

Lower Ordovician (Arenigian) sandstones were sampled in old abandoned quarries in Bukówka (5 sites, 20 hand samples) and Skala Hill in Mójcza (2 sites, 10 hand samples). Both outcrops are cut, respectively, in NE and SW limbs of the local syncline (Fig. 1).

Initial NRM vectors show low intensities (usually of order $5 \cdot 10^{-4}$ A/m) and are fairly distributed (Fig. 3a). Being subjected to the thermal cleaning, Ordovician rocks revealed multicomponent nature of the NRM strongly contrasting with univectorial paleomagnetic record of underlying Cambrian sandstones. Apart

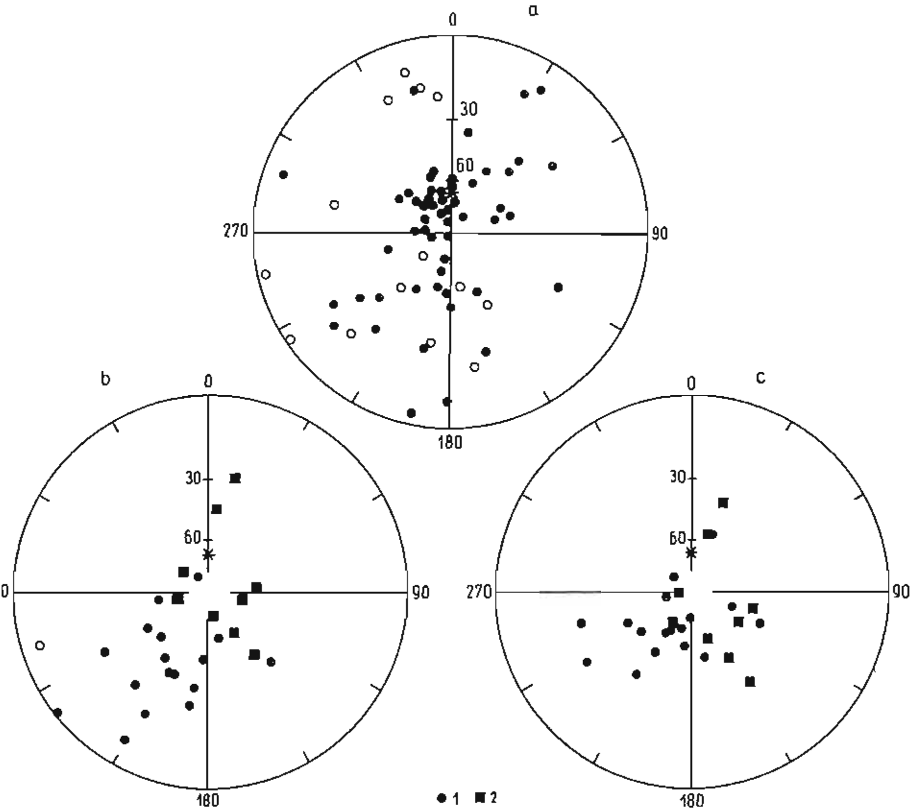

Fig. 3. Initial NRM for specimens of the Lower Ordovician rocks (a) and sample mean directions after demagnetization at the tamperature level of 500°C before (b) and after (c) bedding correction

Początkowe kierunki NRM dla próbek dolnego ordowiku (a) oraz kierunki średnie dla próbek po rozmagnesowaniu w temperaturze 500°C przed (b) i po (c) korekcji na upad warstw

1 – directions from Bukówka, 2 – directions from Mójcza; other symbols are the same as for Fig. 2

1 – kierunki z Bukówki, 2 – kierunki z Mójczy; pozostałe oznaczenia jak na fig. 2

from nicely demagnetized specimens, in many instances (70% of the specimens), demagnetization trajectories displayed more or less chaotic behavior in the zone close to the apparatus noise level. In such cases, a mean from the vectors of the last three temperature levels have been calculated and regarded as characteristic for the specimen, if its semi-angle of the cone of confidence at 95% probability level (M.W. McElhinny, 1973) was less then 20°.

Characteristic directions computed on three different statistical levels, are summarized in Table 2. The slightly better groupping of the NRM (expressed by the increasing values of precision parameter *k*) is observed, when correction for the dip of the strata is applied (Fig. 3b, c). Although not significant at the 95% probability level, this is evidence for prefolding (i.e pre-Emsian) time of acquisition of the NRM, the more so as in view of the HCM expected directions (cf. M. Lewandowski, 1983) post-Caledonian age of the formation mean (assumed to be of post-tectonic origin) is very unlikely.

Table 2

Characteristic NRM and corresponding paleopole positions for the Lower Ordovician (Arenigian) rocks from Mójcza and Bukówka

	Before bedding correction				After bedding correction			
	D	*I*	alfa 95	*k*	*D*	*I*	alfa 95	*k*
Specimens mean, *n* = 53	209°	53°	10.32°	4.6°	196°	70°	8.81°	5.9°
Samples mean, *N* = 27	210°	59°	15.45°	4.0°	191°	74°	12.41°	6.0°
Best groupping temp. level, *N* = 27 *n* = 61, *T* = 300–350°C	214°	60°	11.66°	3.4°	197°	77°	10.33°	4.1°
Paleopole position for sample mean	lat. = 4°N, long. = 358°E				lat. = 15°N, long. = 22°E			
Paleolatitude	not considered				61°S			

Explanations the same as in Table 1

UPPER SILURIAN

Upper Ludlovian (H. Tomczyk, 1974) greywackes have been sampled (15 hand samples, 3 sites) in old quarry of Niestachów (Fig. 1). The strata are tilted to the SSW and their averaged dip is about 40°.

Initial NRM directions are moderately scattered (Fig. 4a) and a little improvement is observed in a course of thermal demagnetization experiment. Intensities of the remanence of all specimens do not exceed $1 \cdot 10^{-3}$ A/m. The best groupping of the vectors is achieved after treatment in 375°C, but non-Fisherian (cf. J.L.

Table 3

Characteristic NRM and corresponding paleopole position for the Upper Silurian (Ludlovian) rocks from neighbourhood of Niestachów

	Before bedding correction			After bedding correction		
	D	*I*	A.S.D.	*D*	*I*	A.S.D.
Formation (*n* = 27) subtracted vector 400°C to origin	229°	27°	5.3	218°	7°	5.3
Paleopole position	lat. = 12°S, long. = 332°E			lat. = 27°S, long. 337°E		
Paleolatitude	14°S			4°S		

A.S.D. – angular standart deviation; remainded explanations the same as in Table 1

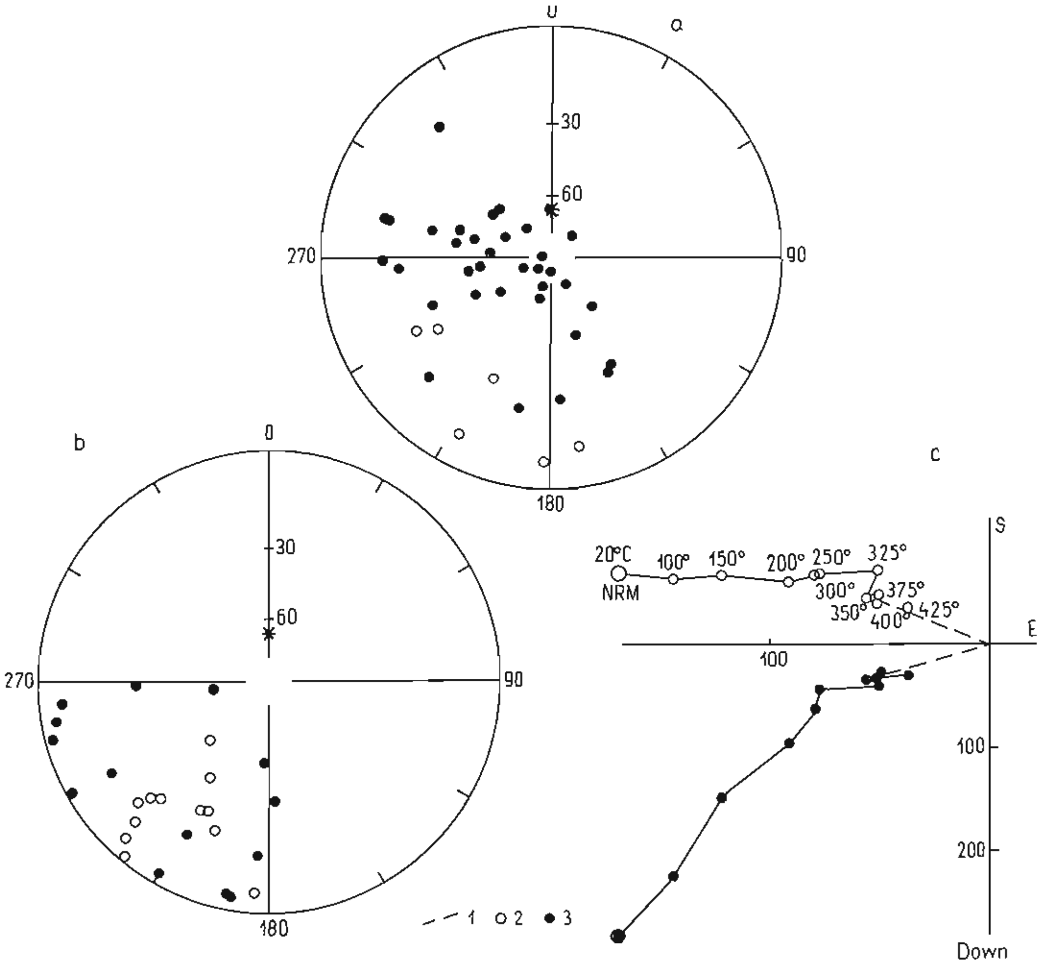

Fig. 4. Initial NRM distribution for specimens from Upper Silurian rocks (a, before tilt correction) and NRM distribution after demagnetization in 375°C (b, after tilt correction); symbols are the same as in Fig. 2; NRM formation mean in the course of demagnetization experiment is presented (c) on J.D.A. Zijderveld (1967) diagram

Rozkład początkowych kierunków NRM próbek górnego syluru (a, przed korekcją na upad) oraz rozrzut wektorów po rozmagnesowaniu w temperaturze 375°C (b, po korekcji na upad); przebieg rozmagnesowania wektora NRM (c), uśrednionego na poziomie formacji, przedstawiono na diagramie J.D.A. Zijdervelda (1967)

1 — the best fit characteristic direction, calculated for the last two demagnetization levels (see Table 3); intensity units along the axes are in $8 \cdot 10^{-7}$ A/m; 2 — vector's end-points, projected on horizontal plane; 3 — vector's end-points, projected on vertical plane

1 — aproksymowany kierunek charakterystyczny, obliczony dla dwóch ostatnich poziomów rozmagnesowania (por. tab. 3); natężenie składowych wyrażono w $8 \cdot 10^{-7}$ A/m; 2 — rzut końca wektora na płaszczyznę poziomą; 3 — rzut końca wektora na płaszczyznę pionową

Kirschvink, 1980), distribution of the NRM inside the population (Fig. 4b) stands in the way of accepting the mean (*D* = 219°, *I* = 0°, alfa 95 = 13°) as characteristic direction. Instead, direction of the line fit (Tab. 3) between formation means at the 400 and 425°C (including origin, Fig. 4c) is thought to be characteristic, being

Tabela 4

Comparison of inclinations and corresponding paleolatitudes for the Holy Cross Mts (HCM) and East-European Platform (EEP)

Age	Inclination				Paleolatitude S						Difference of paleolatitude		
	EEP		HCM		EEP			HCM					
	I(+ –)		*I*(+ –)		mx	int	mn	mx	int	mn	mx	int	mn
I	43°	13°	78°	7°	37°	25°	16°	80°	66°	55°	64°	41°	18°
II	43°	13°	74°	12°	37°	25°	16°	82°	60°	43°	66°	35°	6°
III	23°	6°	17°	–	15°	12°	9°	–	10°	–	– 5°	– 2°	1°

I – Middle/Upper Cambrian, II – Lower Ordovician, III – Upper Silurian - Lower Devonian; *I* – inclination, mx – maximum, int – averaged value, mn – minimum; inclination errors are equivalent of the alfa 95 values (see Table 1 and text); for simplification, inclination of Upper Silurian NRM is represented by arithmetic mean of uncorrected and tilt corrected strata

the best cleaned and the most stable component in the course of the demagnetization procedure. This result, however, is derived from the method ascribing greater statistical weight to the stronger remanence and should only be treated as preliminary.

Since fold test could not be applied, there are two equivalent formation characteristic directions (i.e before and after tilt correction, see Table 3). Discrimination between them can not be conclusively made, but corresponding pole positions are close to Upper Silurian – Lower Devonian European paleopoles (A.N. Khramov, 1982; T. Torsvik, 1985). Whatever, therefore, is the origin of the NRM in the rocks under investigation, it should be regarded as of Caledonian age and its subequatorial character seems to be real.

This tentative result remains in general agreement with the data from Emsian quartz sandstones of Bukowa Quarry (25 km north from Mójcza northern province), where characteristic mean, supposed to be of primary origin, has the direction $D = 231°$ and $I = 0°$ (M. Lewandowski et al., 1987).

PALEOGEOGRAPHIC IMPLICATIONS

Final paleomagnetic data obtained in this study are presented in Fig. 5 where local paleomagnetic directions are compared with Lower Paleozoic directions from EEP (after A.N. Khramov, 1982, pp. 204–205, recalculated on HCM geographic position). It is clear from such comparison that there is significant disagreement of the NRM inclinations and, assuming axial geomagnetic field in Early Paleozoic time, also paleolatitudes between the southern part of the HCM and EEP. The differences between coeval paleolatitudes (Table 4) gradually decrease

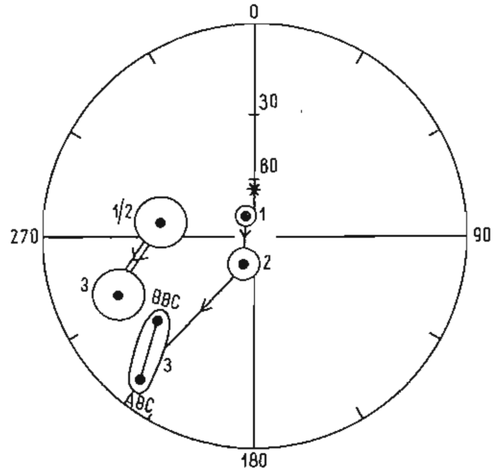

Fig. 5. Schematic curve of the changes of the paleomagnetic directions from Cambrian (1), through Ordovician (2) to Silurian (3) for East-European Platform (double line) and Holy Cross Mts (single line)

Schematyczna krzywa zmian kierunków paleomagnetycznych od kambru (1), przez ordowik (2), do górnego syluru (3) dla platformy wschodnioeuropejskiej (linia podwójna) i Gór Świętokrzyskich (linia pojedyncza)

Circles denote confidence area at the 95% probability level; BBC – before bedding correction; ABC – after bedding correction; directions from East-European Platform (after A.N. Khramow, 1982) have been recalculated on Holy Cross Mts latitude (50°50'N) and longitude (20°30'E)

Kółkami zaznaczono obszar ufności na poziomie 95%; BBC – przed korekcją na upad warstw; ABC – po korekcji na upad warstw; kierunki z platformy wschodnioeuropejskiej (wg A.N. Hramowa, 1982) przeliczono na szerokość (50°50'N) i długość (20°30'E) geograficzną Gór Świętokrzyskich

from the Middle/Upper Cambrian to the Upper Silurian, when the difference finally vanishes. On the other hand, steep inclinations of the HCM area are in agreement with those of Cambrian (J.T. Hagstrum et al., 1980; B.A. Duff, 1980; R.J.E. Johnson, R. van der Voo, 1985) and Ordovician (H. Perroud et al., 1983, 1984; H. Perroud, R. van der Voo, 1985; R. van der Voo, R.J.E. Johnson, 1985) age from Armorica Plate. This implies paleogeographic proximity of the HCM to Armorica and about 4000 (± ca. 2000) km wide ocean between Baltica and southern part of the HCM in the Middle/Upper Cambrian – Lower Ordovician time (see Table 4 for possible errors).

Thus, according to the results presented here, it have to be concluded that the studied area travelled, with averaged velocity around 4 cm/y, from polar province in the Middle/Upper Cambrian time through subpolar latitudes in Lower Ordovician to the equatorial zone at the end of the Silurian. The opposite declinations of the Middle Cambrian and Lower Ordovician characteristic directions indicate either passing over the pole (cf. B.A. Duff, 1980) or 180° rotation in relation to the present day position of the HCM. In the former case the paleodistance between HCM area and EEP would even be greater then presented in Table 4.

Finally, it should be mentioned that almost parallel to the paleolatitudes sinistral strike-slip displacement along Teisseyre-Tornquist Zone, as proposed by W. Brochwicz-Lewiński et al. (1981), is contradictory to the 35 – 40° paleolatitude gap between EEP and HCM deduced in this study, although for extremely favourable error values (see the last column of Table 4) this hypothesis can not be solely excluded. On the other hand, the tentative model of the Early Paleozoic geotectonic development given by P.A. Ziegler (1982) seems to be in accordance with the data obtained here. Following his idea (*op. cit.*), southern part of HCM, most probably being the integral part of the Małopolska Massif, would be one of the Gondwana-derived microcontinents. Since this concept stands in opposition to the widely accepted paleobiological proximity of the HCM area to the EEP (cf. K. Lendzion, 1983), it should be regarded as nothing but a working hypothesis so long as further paleomagnetic investigations both in Holy Cross Mts and East-European Platform do not confirm the existence of paleolatitudinal gap between these areas in the Early Paleozoic.

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WYNIKI WSTĘPNYCH BADAŃ PALEOMAGNETYCZNYCH NIEKTÓRYCH SKAŁ DOLNOPALEOZOICZNYCH GÓR ŚWIĘTOKRZYSKICH*

Streszczenie

Badania paleomagnetyczne piaskowców dolnego kambru, dolnego ordowiku oraz szarogłazów górnego syluru, przeprowadzone w okolicach Mójczy k. Kielc, pozwoliły (po raz pierwszy w Polsce) na wyodrębnienie dolnopaleozoicznych składowych naturalnej pozostałości magnetycznej (NRM). Charakterystyczne kierunki NRM, wyznaczone dla badanych formacji, zestawiono w tab. 1 – 3. Wiek utrwalenia pozostałości magnetycznej można określić następująco:

– podolnokambryjski, a najprawdopodobniej przeddolnoordowicki dla piaskowców dolnego kambru (wtórna geneza NRM);

– przeddolnodewoński, a najprawdopodobniej dolnoordowicki dla piaskowców dolnego ordowiku (pierwotna (?) geneza NRM);

– górnosylursko-dolnodewoński, o nieustalonej genezie, dla szarogłazów górnego syluru.

Prawie pionowe inklinacje NRM, obserwowane w skałach dolnego kambru i dolnego ordowiku,

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świadczą o subpolarnym położeniu badanego obszaru w czasie utrwalania się pozostałości magnetycznej. Konfrontacja uzyskanych wyników z aktualnymi, równowiekowymi danymi z platformy wschodnioeuropejskiej (według A.N. Hramowa, 1982) prowadzi z jednej strony do wniosku, że przynajmniej od końca kambru dolnego po dolny ordowik porównywane regiony były oddalone od siebie o ok. 4000 (±2000) km (tab. 4). Z drugiej strony inklinacje NRM skał kambryjskich i ordowickich masywu świętokrzyskiego pozostają w zgodzie z równowiekowymi inklinacjami płyty armorykańskiej (por. J.T. Hagstrum i in., 1980; B.A. Duff, 1980; H. Perroud i in., 1983, 1984; R.J.E. Johnson, R. van der Voo, 1985; H. Perroud, R. van der Voo, 1985; R. van der Voo, R.J.E. Johnson, 1985), sugerując – przy założeniu osiowego, dipolowego pola geomagnetycznego w dolnym paleozoiku – zbliżone paleoszerokości południowo-zachodniej części Gór Świętokrzyskich i Masywu Armorykańskiego. Kierunki NRM, wyznaczone w górnosylurskich szarogłazach Niestachowa, są zgodne w granicach błędu z kierunkami sylursko-dolnodewońskimi platformy wschodnioeuropejskiej, świadcząc o podobnej do dzisiejszej konfiguracji paleogeograficznej dyskutowanych obszarów u schyłku epoki kaledońskiej.

Ze względu na małą reprezentatywność danych paleomagnetycznych z platformy wschodnioeuropejskiej oraz masywu świętokrzyskiego, przedstawiony wyżej szkic paleogeograficzny może być uważany jedynie za roboczą hipotezę, której potwierdzenia lub negacji należy poszukiwać zarówno w badaniach paleomagnetycznych, prowadzonych po obu stronach granicy platformy wschodnioeuropejskiej, jak i analizach paleobiologicznych oraz sedymentologicznych.

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ИТОГИ ПРЕДВАРИТЕЛЬНЫХ ПАЛЕОМАГНИТНЫХ ИССЛЕДОВАНИЙ НЕКОТОРЫХ НИЖНЕПАЛЕОЗОЙСКИХ ПОРОД В СВЕНТОКШИСКИХ ГОРАХ

Резюме

Изучение палеомагнитных свойств песчаников нижнего кембрия, нижнего ордовика и граувакк верхнего силура, залегающих в окрестностях Муйчи, около Кельц, позволили (впервые в Польше) выделить естественную остаточную намагниченность нижнепалеозойских пород (NRM). Характерные направления NRM, определенные для исследуемых формаций, представлены на таблицах 1—3. Возраст закрепления естественной остаточной намагниченности пород нижнего палеозоя можно считать следующим:

— посленижнекембрийский, а вероятнее всего донижнеордовикский для песчаников нижнего кембрия (вторичный генезис NRM);

— донижнедевонский, скорее всего нижнеордовикский для песчаников нижнего ордовика (первоначальный ? генезис NRM);

— верхнесилурско-нижнедевонский с неопределенным генезисом для граувакк верхнего силура.

Почти вертикальное наклонение NRM наблюдаемое в породах нижнего кембрия и нижнего ордовика, свидетельствует о субполярном положении исследуемой области во время закрепления естественной остаточной намагниченности горных пород. Сопоставление полученных данных с актуальными одновозрастными данными по Восточно-Европейской платформе (по А.Н. Храмову, 1982) с одной стороны позволяет сделать вывод о том, что по крайней мере с конца нижнего кембрия по нижний ордовик сравниваемые районы располагались на расстоянии 4000 (±2000) км друг от друга (таб. 4). С другой стороны, наклонение NRM кембрийских и ордовикских пород Свентокшиского массива совпадает с одновозрастными наклонениями арморикanской плиты (ср. Я.Т. Хагструм и др., 1980; Б.А. Дуфф, 1980; Г. Перроуд и др., 1983, 1984; Р.Е.Э. Джонсон, Р. ван дер Ву, 1985; Г. Перроуд, Р. ван дер Ву, 1985; Р. ван дер Ву, Р.Е.Э. Джонсон, 1985), предполагая при установлении осевого дипольного геомагнитного поля в нижнем палеозое одинаковую палеоширину юго-западной части Свентокшиских гор и Арморики. Направления NRM, определенные в верхнесилурских граувакках Нестахова, совпадают в пределах погрешности с силурско-нижнедевонскими направлениями Восточно-Европейской платформы, что служит доказательством сходства палеогеографической конфигурации изучаемых районов на исходе каледонской эпохи с современной.

Ввиду малой представительности палеомагнитных данных по Восточно-Европейской платформе и Свентокшискому массиву, предложенную палеомагнитную схему можно считать рабочей гипотезой, подтверждения или отрицания которой следует искать в палеомагнитных исследованиях, проводимых с обоих сторон границы Восточно-Европейской платформы, а также в палеобиологических и седиментологических данных.