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A paleomagnetic cross-section through the Ardenne and the Brabant Massifs (France-Belgium)

J.B. Edel[1] **and M. Coulon**[2]

[1] Institut de Physique du Globe, 5 rue Descartes, 67084 Strasbourg, Cedex, France
[2] Groupe d'Etudes Géologiques de l'Université de Reims, Laboratoire de Géologie Régionale et Pétrologie Structurale (Nancy I), Faculté des Sciences, 51062 Reims Cedex, France

Abstract. In order to constrain the motions of the allochthonous Ardenne during the Paleozoic, standard paleomagnetic techniques have been applied on acidic and basic sills of the Cambrian Rocroi massif and on Cambrian-to-Visean sedimentary series sampled along the Meuse valley. Ordovician–Silurian volcanics and Devonian–Visean limestones have also been collected in the autochtonous Brabant and Namur basin, in order to get paleomagnetic reference poles.

In the Ardenne, two groups of in situ paleomagnetic directions arise. The A components (mean: $D=212°$, $I=-11°$, $\alpha_{95}=6°$, for 10 sites), that are characterized by unblocking temperatures around 330° C, represent Late Variscan (Stephanian–Permian) overprints. The B components (mean: $D=236°$, $I=2°$, $\alpha_{95}=11°$, for 13 sites) display higher unblocking temperatures, in the range 400°–580° C. They show a large scatter in inclination ($-25°<I<35°$) that is not reduced by tectonic correction. The B components are interpreted as post- and partly synfolding overprints of Middle–Late Carboniferous age. In the Brabant, all series display Late Variscan remagnetizations (mean: $D=204°$, $I=-7°$, $\alpha_{95}=9°$, for 5 sites), consistent with the Stephanian–Permian pole of Europe.

The existence of Middle-to-Late Variscan B directions in the Armorican Massif, Central Massif, Vosges and Black Forest indicates that in Namurian–Westphalian times the whole investigated Variscan belt, including the Ardenne, was trending N-S. A 45° clockwise rotation relative to the paleomeridian, during the latest Westphalian–Stephanian, has lead the massif to its Permian position.

Key words: Paleomagnetism – Paleozoic – Ardenne – Brabant – Remagnetizations – Rotations

Introduction

The folded and metamorphosed Paleozoic series of the Ardenne massif are limited to the north by a major tectonic feature, the Midi fault. Reflection seismic surveys and deep drilling show that this large thrust fault dips under the Ardenne and continues under the Paris basin, where it reaches the boundary between upper and lower crust (Ecors, 1984).

The objectives of this study are to follow the movements, both in paleolatitude and direction, of the Ardenne and the Brabant during Devonian–Carboniferous times and, particularly, to see whether paleomagnetism can give information on the Variscan motions that have initiated the Midi fault overthrust.

The paleomagnetic study has been performed on Paleozoic series outcropping along the Meuse valley, from the Rocroi massif to the region of Namur and along the E-W belt of Silurian–Ordovician magmatism of the Brabant (Fig. 1). The investigated area is crossed by the Variscan front. In the Brabant, the youngest ages of metamorphism, i.e. 400–375 Ma, represent the latest phase related to Caledonian folding (André et al., 1981). In the Hercynian Ardenne, a thermal phase dated at 316 Ma (Michot, 1976) affected the region along the anticlinal axis. Near the Midi fault, a late Variscan age of 297 Ma, probably related to the latest thrusting phase (Piqué et al., 1984), has been obtained. According to Beugnies (1983), the Ardenne has been affected by E-W strike-slip faulting, after folding and metamorphism.

The Ardenne sites

In the Ardenne massif, the grades of metamorphism and of the schistosity decrease from south to north (Beugnies, 1962; Dandois, 1981; Piqué et al., 1984). North of the Cambrian Rocroi massif, which is overlapped by discordant Devonian, the isogrades remain parallel to the stratigraphic series. Sampling has been carried out on a S-N profile that crosses these isogrades.

The Rocroi massif

Samples were collected mainly in diabase sills (sites Ar 2A, 2B, 3, 6) and microgranite sills (sites Ar 1, 4, 5, 19) intruded into metamorphic silts and sandstones (Beugnies, 1962) (Fig. 1). The microgranites seem to be younger than the diabases. They were probably emplaced at the same time as the rhyolitic volcanics of Willerzie that outcrop at the eastern border of the Rocroi massif (sites Ar 7, 8, Fig. 1). The different facies are due to different metamorphic paragenesis, to hydrothermal activity and to the conditions of emplacement. Two sites have been drilled in epimetamorphic series south of the axis of maximum metamorphism (sites Ar 9, 10).

Offprint requests to: J.B. Edel

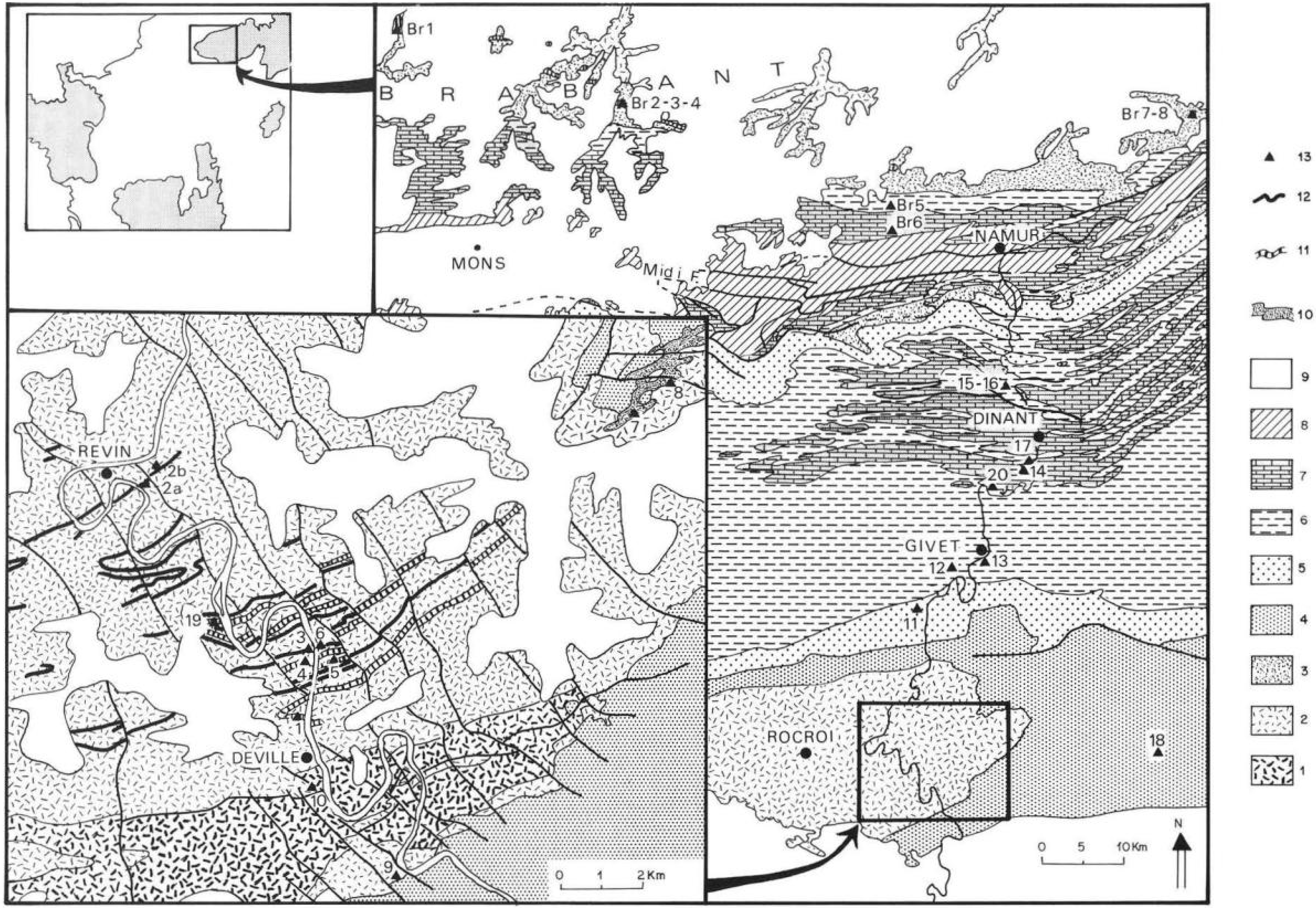

Fig. 1. Geological map of the western Ardenne and location of the paleomagnetic sites. 1: Cambrian–Devillian of the Rocroi massif; 2: Cambrian; 3: Silurian; 4: lower Devonian; 5: middle Devonian; 6: upper Devonian; 7: Dinantian; 8: Silurian; 9: post-Paleozoic; 10: volcanics of Willerzie; 11: microgranites; 12: diabases; 13: sampling sites

The Devonian series

It is composed of an alternation of detritic and carbonated layers. Sampling has been carried out in Emsian sandstones (site Ar 11) and in lower Givetian limestones. Site Ar 12 layers are in a normal position, those of site Ar 13 in a reversed. Site Ar 20 corresponds to a cross-section starting in Famennian limestones and ending in Etroeungtian limestones (Strunian). Two sites (Ar 7, 8) are located in the rhyolite of Willerzie, close to the eastern discordance of the Rocroi massif (Beugnies et al., 1976).

The Dinantian series

Sampling has been performed at different levels of the mainly calcareous series:
- the Tournaisian lower boundary (site Ar 17).
- the Tournaisian–Visean boundary (site Ar 14)
- the middle Visean (site Ar 15)
- the upper Visean (site Ar 16).

The Brabant and the northern Namur syncline sites

The Brabant dacites

The early Paleozoic series, generally hidden by Tertiary deposits, outcrop only in some valleys and in quarries. The Cambrian, which presents some analogy with that of the Ardenne massif, is overlapped by a thick phyllitic Silurian–Ordovician series. The Silurian–Ordovician boundary is characterized by volcanic formations that extend along an arc Ostende–Liege. The site of Lessines (Br 1) has been sampled in a piling of several hundred sills dated at 419 Ma (André and Deutsch, 1984). The samples show a low-temperature paragenesis with quartz, albite, chlorite and epidote. Near Fauquez, the volcanic series is composed of lavas, pyroclastites (site Br 4) and volcanic sedimentary layers (Br 2). Analysis of thin sections reveals a similar composition as in the dacites of Lessines; however, the effects of hydrothermal alteration and Caledonian tectonics are more pronounced. Further to the east, at le Pitet, the tuffs (Br 7) and lavas (Br 8) of Wenlockian age are hardly affected by hydrothermal activity and schistosity.

The limestones of the Namur syncline

North of the Namur syncline, Givetian (Br 5) and middle Visean (Br 6) limestones were collected. The Givetian marks the southern border of the Brabant massif, whereas the Visean series correspond to the northern limb of the Namur syncline.

Sampling and laboratory techniques

The samples were drilled or collected as hand samples and oriented with magnetic and, whenever possible, solar compass. In the laboratory the cored samples, 2.5 cm in diameter, were cut into 2.2-cm-long specimens. Remanent magnetizations were measured with a Digico magnetometer (Molyneux, 1971). Its noise level has been reduced to 3×10^{-5} Am^{-1}. We used alternating field (AF) and thermal demagnetizing units and a Curie balance, built in our laboratory. The low field susceptibility measurements were performed with a Digico susceptibility bridge.

Rock magnetism

The sills and flows

Natural remanent magnetizations range from 10^{-4}–10^{-1} Am^{-1} in the microgranites and from 10^{-4}–1 Am^{-1} in the diabases. Susceptibilities are less dispersed. In the diabases they group around 10^{-2}, while in microgranite they are weaker. In most cases the Koenigsberger ratio (remanent magnetization divided by induced magnetization: $Q = J/KH$) remains lower than *1*. The thermomagnetic curves display Curie temperatures of 320°–350° C, 500°–580° C and/or 620°–650° C. In one microgranite, the curve shows a "hump" in the range 420°–580° which is due to production of magnetite above 420°. During cooling, the curves reveal various behaviours. A common feature is the creation of ferro/ferrimagnetic material with Curie temperatures of 450°–580° C.

The sediments

Most of the sampled sediments are limestones. The intensities of NRM apparently depend on the age of the series. The Givetian limestones show the highest values (in the range 2×10^{-3}–2×10^{-2} Am^{-1}), while the Visean range between 10^{-4} and 10^{-3} Am^{-1}. As the susceptibilities show the same tendency, it is concluded that the amount of magnetic material is greater in the Devonian limestones than in the Carboniferous.

The thermomagnetic curves usually reveal changes of the magnetic mineralogy during the heating and/or cooling process. In the limestones, the "humps" are common in the range 420°–580° C. In most cases the magnetizations hardly increase during cooling. The created ferro/ferrimagnetic materials exhibit Curie temperatures of 280° and/or 580° C, the latter corresponding to magnetite.

The remanent magnetizations

(Table 1, Figs. 2 and 3)

Pilot demagnetization tests have shown that thermal treatment separates the different components of NRM better than AF cleaning. Consequently, most of the 340 specimens were demagnetized thermally.

The sills and flows

Most microgranite samples are characterized by a magnetic component that cannot be demagnetized because of magnetic changes above 330°–400° C. The destroyed material is supposed to be maghemite or a sulphide. AF demagnetizing does not appear to be more efficient. At sites Ar 4, 5 and 19, the magnetization often diverges above 330°–400° C. With exception, most characteristic directions were obtained from the computation of a mean direction in the range 100°–300° C.

Site Ar 1 was sampled in a thick sill not much affected by hydrothermal alteration. Demagnetization reveals a first

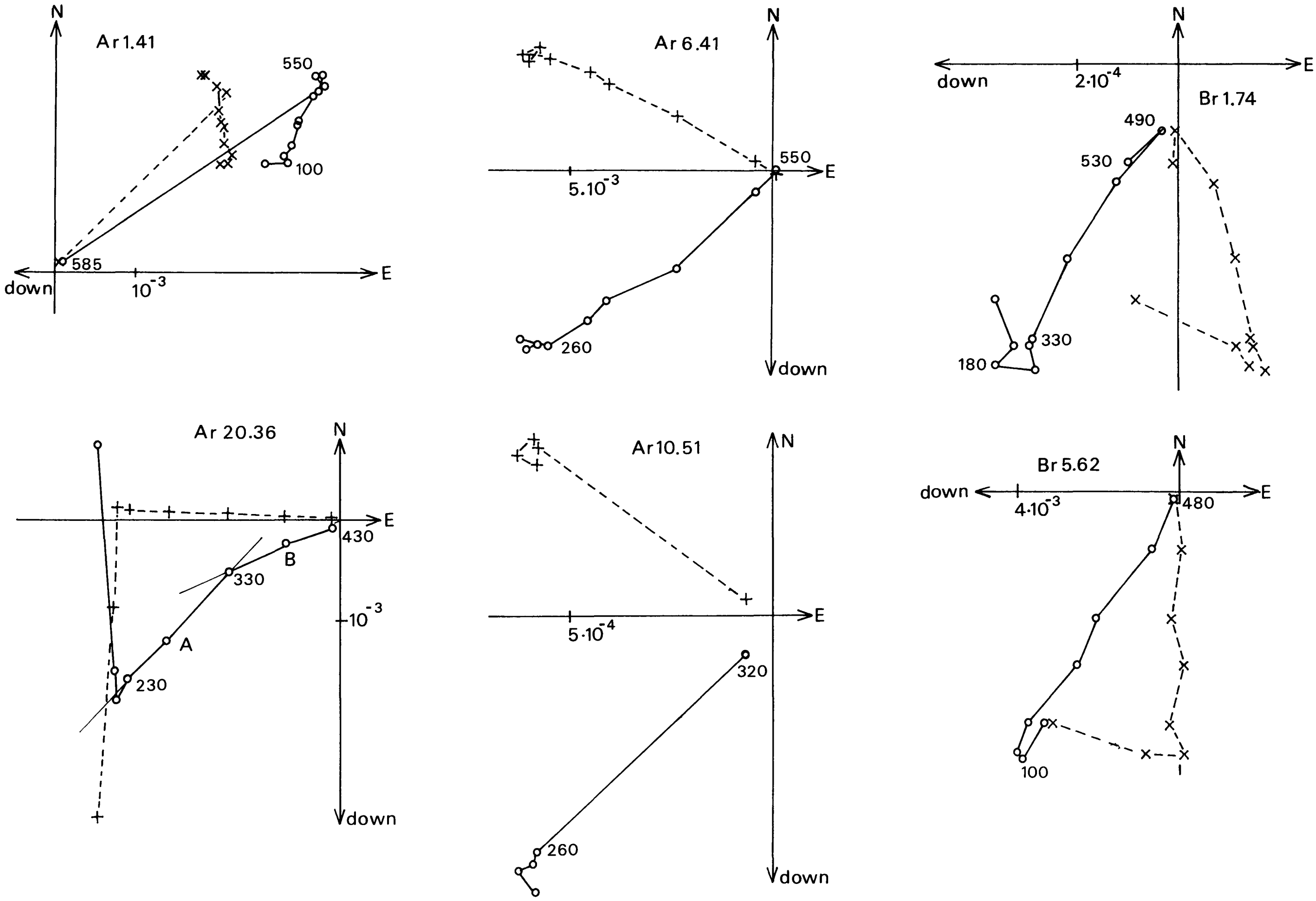

Fig. 2. Typical vector diagrams of thermal demagnetization. Ar 1.41: microgranite; Ar 6.41: diabase; Ar 20.36: Strunian limestone; Ar 10.51: Cambrian schist; Br 1.74: dacite of Lessines; Br 5.62: Givetian limestone. Orthogonal projections in the horizontal plane (o) and in the E-W (+) or N-S (×) vertical planes. The intensities of remanent magnetization are given in Am^{-1}

component that disappears at 550° C and a second one, roughly opposite in direction, carried by magnetite (Fig. 2, Ar 1.41). Magnetite seems to have been a primary mineral in microgranites. It was probably oxidized into maghemite in the hydrothermalized sills.

In the diabases of sites Ar 3 and Ar 6, which are the least altered, one observes unblocking temperatures of 550°–580° C that reveal magnetite as the main carrier of magnetization. At site Ar 2a and particularly at site Ar 2b, which are affected by hydrothermal alteration, the unblocking temperatures drop down to 330° C, revealing the presence of maghemite.

The rhyolite of Willerzie is characterized by both high (Ar 7) and low (Ar 8) unblocking temperatures (Table 1). North of the Midi fault, the Brabant dacites show maximum unblocking temperatures of at least 500° C (Fig. 2, Br 1.74). Because of the weak intensities of magnetization it was not possible to obtain a precision for these temperatures. In a few cases magnetite was revealed by the thermal treatment.

The sediments

After elimination of a soft viscous magnetization at 100°–180° C, the Ardenne limestones and sandstones reveal two ranges of maximum unblocking temperatures, i.e. 320°–360° C and 400°–500° C (Fig. 2, Ar 20.30 and Ar 10.51). Sample Ar 20.36 shows the behaviour of all specimens of sites Ar 14 and Ar 20: after demagnetizing a first component with declinations of 210°–220° at about 330° C, there remains a second component, more deviated to the west, with declinations in the range 230°–240° and a maximum unblocking temperature around 450° C. Later, these components will be called *A* and *B* magnetizations, respectively. In the Cambrian of site Ar 10 (Ar 10.51, Fig. 2) and in the Devonian sandstones and limestone of sites Ar 1, 12, 13, only the low-temperature component (Curie temperature $\simeq$330° C) was exhibited. North of the Midi fault, the Devonian and Visean limestones (Ar 5, 6) display much higher maximum unblocking temperatures up to 500° C (Br 6.62, Fig. 2).

The presence of macroscopic pyrite in the limestones and the behaviour of the thermomagnetic curves suggest that iron sulphides carry at least a part of the remanent magnetizations. Curves very similar to our thermomagnetic curves have been obtained by Kruczyk (1983) for sediments containing iron sulphides. The unblocking temperature of 320° C may be due to pyrrhotite, whereas the higher temperatures may correspond to more or less oxidized pyrrhotite.

Table 1. Site mean directions of remanent magnetizations. T_b: maximum unblocking temperatures; N/No: number of samples that carry the considered magnetization/total number of samples; n: number of specimens taken into account; D, I: in situ declination and inclination; k, α_{95}: Fisher statistic parameters. A, B: mean directions for magnetizations with respective maximum unblocking temperatures of 300°–360° C and 400°–580° C. The doubtful results are not plotted in Figs. 5 and 4

Site	Formation, age	T_b	N/No	n	D	I	k	α_{95}
Ar 1	microgranite	520–550	5/ 6	6	221	−10	23	14
		580	5/ 6	10	61	−30	72	6
Ar 2a	diabase	330–460	2/ 5	6	241	39	29	13
		330–370	2/ 5	4	152	54	39	15
Ar 2b	diabase (altered)	—	3/ 5	4	274	−44	13	27
		330	4/ 5	7	213	− 5	30	11
Ar 3	diabase	300–370	3/ 6	10	31	5	55	7
		500–580	6/ 6	10	233	−21	54	7
Ar 4	microgranite	≥400	3/ 4	5	134	−35	53	11
		≥400	4/ 4	5	238	− 4	20	17
Ar 5	microgranite	230	2/11	3	215	5	11	40
		≥330	7/11	10	243	27	10	16
Ar 6	diabase	≥330	1/ 6	3	213	−14	19	29
		250–350	3/ 6	4	263	−22	53	13
		550–580	5/ 6	10	235	−17	67	6
Ar 7	volcanites	500–550	2/ 7	2	305	−24	—	—
		≥500	2/ 7	3	48	0	51	18
Ar 8	volcanites	350–450	6/ 9	9	233	−20	79	6
Ar 9	schists, Cambrian	350	3/ 6	4	195	−19	30	17
		>580	2/ 6	2	274	88		
Ar 10	schists, Lower Cambrian	320–350	6/ 9	10	224	− 8	47	7
Ar 11	sandstones, Lower Emsian	—	7/ 7	13	215	− 4	8	15
Ar 12	limestones, Lower Givetian	360	9/ 9	13	216	−25	15	11
Ar 13	limestones, Lower Givetian	360	8/ 8	9	213	−15	75	6
Ar 14	limestones,	330–350	3/ 6	3	208	− 5	23	26
	Tournaisian/Visean boundary	450–500	6/ 6	8	230	− 7	60	7
Ar 15	limestones, Middle Visean	330–450?	3/ 4	7	235	16	34	10
Ar 16	limestones, Upper Visean	??	2/ 3	4	234	16	29	17
Ar 17	limestones + sandstones,	260–350	5/ 5	10	210	− 2	62	6
	Strunian-Tournaisian	450–500	5/ 5	9	208	13	52	7
Ar 19	microgranite	350–450	4/ 4	4	206	−14	37	15
		400–500	4/ 4	8	239	−16	28	11
Ar 20	limestones + sandstones,	300–350	3/ 6	7	214	−12	69	7
	Fammenian-Strunian	450–500	6/ 6	13	240	−15	31	8
	Mean B	400–580		13	236	2	16	11
	Mean A	300–400		10	212	−11	61	6
Br 1	dacite	450–500	6/11	16	204	−13	41	6
Br 2	tuffs							
Br 4	dacite	450–500	3/ 6	4	84	−24	16	24
		>500	4/ 6	4	197	−16	31	17
			4/ 6	5	169	−16	34	13
Br 5	limestones, Givetian	450–480	8/ 8	13	206	− 3	305	2
Br 6	limestones, Middle Visean	450–500	6/ 6	8	212	4	143	5
Br 7+8	tuffs + rhyolites	≥500	8/ 8	12	199	− 9	46	6
	Mean			5	204	− 7	67	9

The directions of remanent magnetization

Figure 3 and Table 1 give the mean in situ directions obtained at each site for the different components of magnetization. Bedding was measured in all sedimentary series. Concerning the sills, whose ages are still unclear, we dispose only of their tectonic position in the folded sedimentary environment. The possibility that they were emplaced after a first folding phase cannot be excluded.

The Ardenne massif is characterized by a predominance of southwesterly directions. Three sites display directions which may have a normal polarity (Ar 1, 3, 7). Bedding correction, when possible, increases the dispersion, indicating that all sites have been remagnetized. In order to facilitate the analysis, all directions have been plotted on a rectangular D versus I diagram (Fig. 4). The normal directions have been reversed.

Figure 4 displays two groups of directions which differ by their unblocking temperatures. The low-temperature A magnetizations (300°–360° C) present a mean direction $D=212°$, $I=-11°$, $\alpha_{95}=6°$ (VGP: 38° N, 143° E) that is consistent with the direction computed from the late Carboniferous–early Permian pole for Europe (43° N, 167° E, after

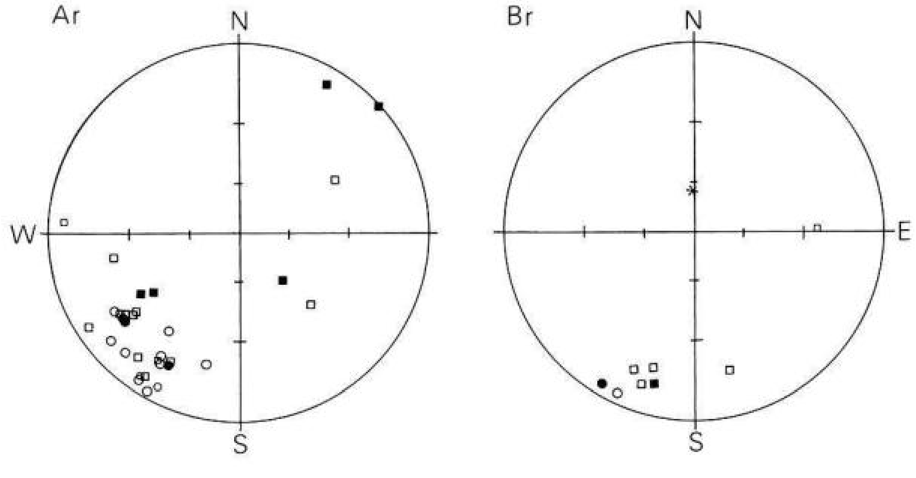

Fig. 3. Stereographic projection of the site mean in situ directions in the Ardenne massif (Ar) and in the Brabant (Br). Sills and volcanics are represented by *squares*, sediments by *dots*. *Full symbols:* lower hemisphere; *open symbols:* upper hemisphere; *asterisk:* present day field

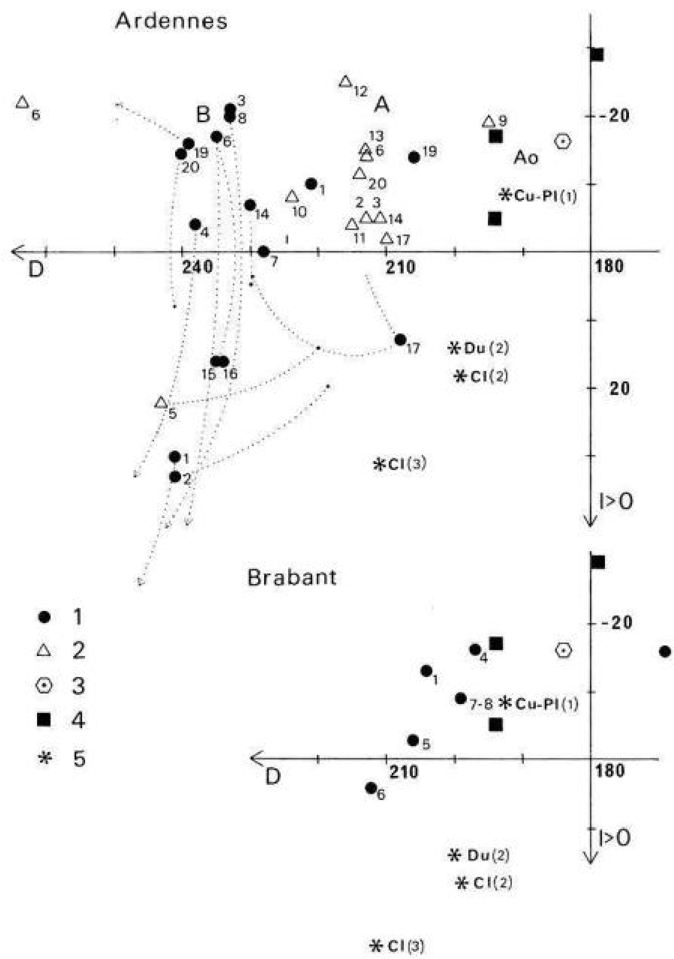

Fig. 4. Declination (**D**) versus inclination (*I*) diagram of the in situ directions of magnetization. The normal directions have been reversed. 1: Directions of magnetizations with maximum unblocking temperatures $400° < t_b < 580°$; 2: low-temperature magnetizations $300° < t_b < 360°$; 3: remagnetized directions in the Sauerland (Bachtadse, 1983); 4: primary magnetizations of the Permian volcanics of the Saar-Nahe basin (Nijenhuis, 1961; Berthold et al., 1975); 5: directions computed from the VGP of Europe after 1: Westphal, 1976; 2: French, 1976; 3: Duff, 1980. The *dotted lines* represent the bedding correction paths

Westphal, 1976), if one assumes a clockwise rotation of the declination of about 20°. Directions obtained on early Permian acidic volcanics from the Saar-Nahe basin, which is located south-west of the Rhenish massif (Fig. 4), are typically "European" (Nijenhuis, 1961; Berthold et al., 1975). The negative fold test and the apparent late Carboniferous–early Permian mean inclination of the *A* components indicate a late Variscan magnetic overprint of the western Ardenne massif. Sites which contain a unique *A* component are mostly characterized by hydrothermal alteration. The yellow-orange colour of some samples is a visible consequence of the alteration. The *A* remagnetizations result, very probably, from a low-temperature hydrothermal alteration phase that occurred during the Kiaman reversal, in Stephanian–Permian times. Site 3 displays a normal *A* component that may have taken place either before the reversal or during a short normal period within the Kiaman reversal. Such a normal period exists in the Permian Saar-Nahe volcanics (Berthold et al., 1975).

Samples of the *B* group are characterized by higher unblocking temperatures (400–580° C) than the *A* components. They present a large scatter of inclinations ($-25° < I < 35°$), whereas the declinations remain around $D = 236° \pm 5.5°$. As the bedding correction increases the dispersion even more (Fig. 4), the magnetizations are post- or synfolding overprints. At site Ar 14, the Visean–Tournaisian samples have been collected on a decametric syncline. The directions of magnetizations are identical at places with different attitude within the fold. This indicates that the remagnetization process occurred after folding. Nevertheless, the possibility of a later tilting of the fold axis and/or of the whole fold cannot be excluded. The tectonic paths corresponding to the bedding correction of the Devonian–Visean limestone series directions (sites Ar 14, 15, 16, 17, 20, Fig. 4) suggest that the tectonic activity was probably not completed after the remagnetization process. The unblocking temperatures of 400°–580° C let us suppose that the overprints are related to a heating phase. According to Michot (1976), a thermal metamorphism affected the region along the anticlinal axis of the massif around 316 Ma (age recalculated for $\lambda^{87}Rb = 1.42 \times 10^{-11}\ a^{-1}$). More to the east, in the northern Rhenish Massif that extends the Ardenne metamorphism, ages of 305–315 Ma are related to folding (Ahrendt et al., 1983). As the *B* magnetizations concern Visean series (Ar 15–16), they are surely post Visean, probably Namurian–Westphalian.

As all magnetizations found in the Ardenne massif are overprints, it seems highly questionable whether magnetostratigraphic studies have any significance in this area (Kolesov, 1984).

The Brabant series display site mean directions close to the Permian volcanics of the Saar-Nahe basin and to the direction computed from the European late Carboniferous – early Permian VGP, with slight deviations of the declinations. At sites Br 6 and Br 7–8, the fold test indicates that the magnetization has taken place after folding. At the other sites the bedding corrections are too weak for a fold test. The ages of metamorphism (400–375 Ma) are inconsistent with the paleomagnetic results. The 450°–500° C unblocking temperatures lead to a late Variscan hydrothermal phase as responsible for remagnetization. The effects of this alteration are particularly visible in the volcanics of sites Br 4 and Br 7–8. The mean direction computed for these late Variscan overprints is $D=204°$, $I=-7°$, $\alpha_{95}=9°$ (VGP: 39° N, 153° E).

Discussion and conclusion

The *B* directions represent post- and/or partly syntectonic magnetic overprints emplaced after the Visean, probably during the Namurian–Westphalian. The scattered inclinations preclude definite conclusions being drawn on the paleolatitudes. On the contrary, as shown in Fig. 4, the mean declination does not change significantly when assuming a partial unfolding or not. The low unblocking temperatures and the negative fold test relative to the *A* magnetizations indicates that they were emplaced after the *B* magnetizations. Their inclinations are in favour of a Stephanian–Autunian age corresponding to the Kiaman reversal. The change from *B* to *A* directions has to be interpreted in terms of geodynamics. The same inference can be drawn for the change from *A* to A_0, A_0 being the mean late Carboniferous–early Permian direction of Europe. One has to discuss now if these deviating declinations are due to local, regional or global rotations.

B directions exist also in other Paleozoic outcrops of the Variscan belt (Edel, 1986), e.g., in the Laval Basin (Armorican Massif), the Central Massif, the Vosges and the Black Forest, where they characterize post-Visean, mainly

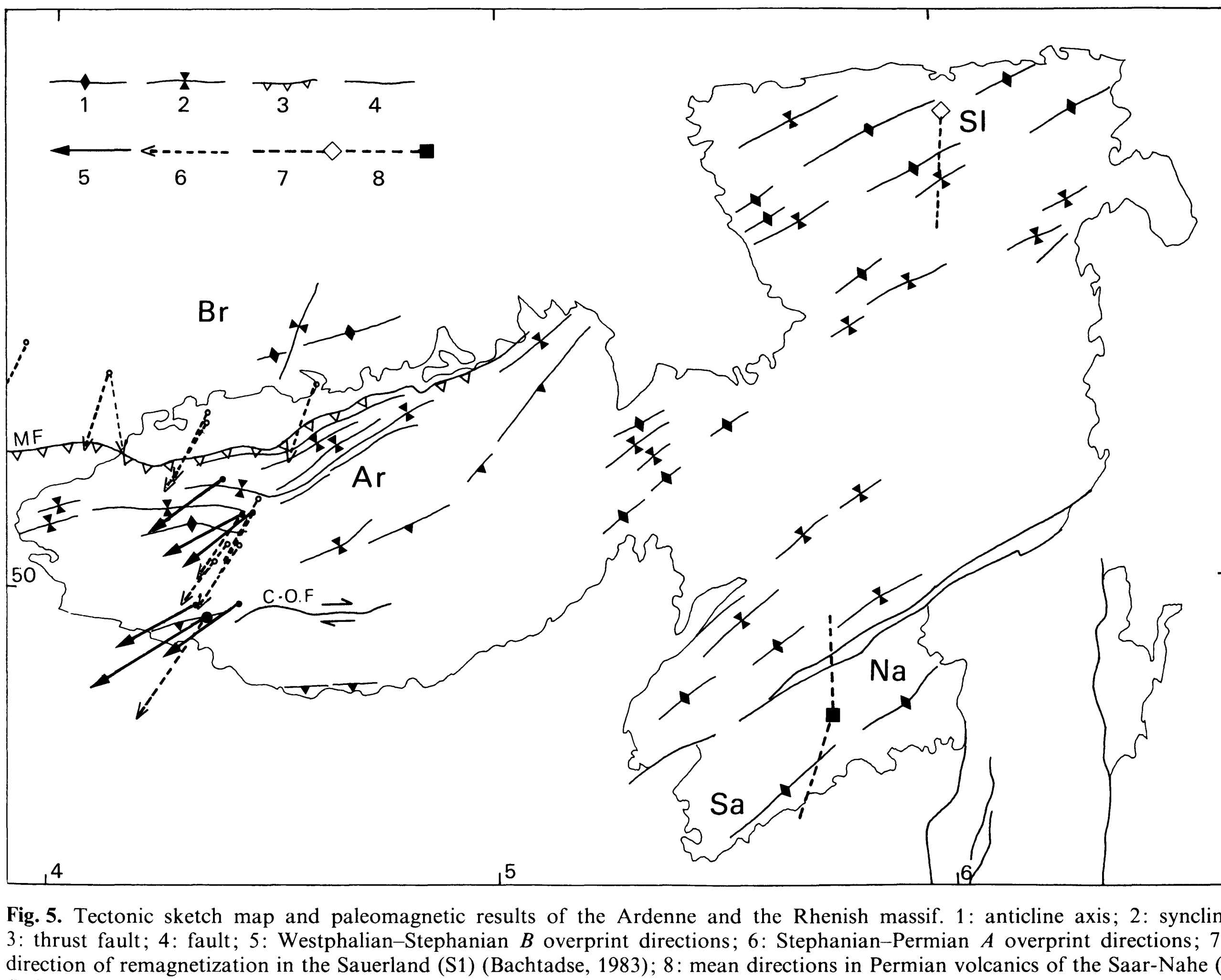

Fig. 5. Tectonic sketch map and paleomagnetic results of the Ardenne and the Rhenish massif. 1: anticline axis; 2: syncline axis; 3: thrust fault; 4: fault; 5: Westphalian–Stephanian *B* overprint directions; 6: Stephanian–Permian *A* overprint directions; 7: mean direction of remagnetization in the Sauerland (S1) (Bachtadse, 1983); 8: mean directions in Permian volcanics of the Saar-Nahe (Sa-Na) (Nijenhuis, 1961; Berthold et al., 1975); MF: Midi fault; C-O.F.: La Carbonnière-Opont strike-slip fault

Namurian–Westphalian overprints and primary magnetizations (Edel and Coulon, 1984; Edel et al., 1981; Edel, 1984, 1985; Edel et al., 1986). In south-west Great Britain, Devonian Old Red sandstones exhibit Carboniferous–Permian remagnetizations with *B* WSW declinations and low inclinations (McClelland Brown, 1983). As a consequence of these deviating declinations we have proposed a paleogeographic reconstruction with the Variscan belt trending N-S in Namurian–Westphalian times (Edel, 1986). The results from Ardenne demonstrate that at this time the massif had the same N-S orientation. The change in declination from *B* to *A* results from a clockwise rotation of the whole belt in the 310–290 Ma time span. The existence in the coal basin of Saar-Lorraine of a discordance, attributed to the Asturian phase at the Westphalian–Stephanian boundary, may be a result of this general motion (Donsimoni et al., 1980).

The change from A to A_0 can be interpreted in two ways. As directions close to A exist also in other regions, the A overprint may represent an intermediate stage of the clockwise rotation that has affected the whole belt. The other interpretation has more local consequences. Overprints with inclinations similar to the A group were found in the Sauerland, north-east of the Rhenish Massif (Bachtadse, 1983, Fig. 5). The deviation of the declination between both regions ($\simeq 30°$) is of the same order as the difference of orientation of the fold axes (15°–30°, Fig. 5). This leads us to explain the bend of the Ardenne by a late Variscan clockwise rotation of the western part of the massif relative to the eastern. In both cases, the existence of E-W dextral strike-slip faults may be a consequence of the clockwise rotation. South of the massif, the "La Carbonnière-Opont" fault shows a dextral offset of 15–18 km (Beugnies, 1983) (Fig. 5).

Results from Brabant are more difficult to interpret. Their magnetic characteristics are those of the Ardenne B group, but the directions are intermediate to A–A_0. We are not able to say if they have been emplaced together with the B, the A or the A_0 overprints. If they are of the same age as the B overprints, then the Brabant has kept the same position from the Namurian to the Permian, while the Ardenne and the rest of the belt have rotated clockwise. The rotation of the Ardenne relative to the Brabant would imply that the late Variscan Midi fault overthrust had an important rotational component. In the other case, a Stephanian–Permian age of the Brabant overprints precludes any conclusion being drawn on the Permian positions of the massif and consequently on the relative motions Ardenne–Brabant.

In short, during the middle-late Carboniferous, the Ardenne had the same paleomagnetic behaviour as the internal zones of the Variscan belt. In the Brabant massif, no reliable paleomagnetic reference pole older than Stephanian–Permian could be found.

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