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The Guiana and the West African Shield Palaeoproterozoic grouping: new palaeomagnetic data for French Guiana and the Ivory Coast

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SUMMARY

The aim of this study is to document the Palaeoproterozoic palaeomagnetic database for the Guiana and West African Shields in order to better understand the paleogeographic evolution of these two cratons. A total of 59 sites were sampled (33 in French Guiana and 26 in the Ivory Coast) in granites and metavolcanic rocks. Magnetic, petrographic and palaeomagnetic investigations were carried out on these rocks. Magnetic experiments and petrographic observations show that undeformed magnetite is the main magnetic remanent carrier in granites of French Guiana and both magnetite and haematite in rocks from the Ivory Coast. Both thermal and magnetic alternating-field demagnetizations were applied to the rocks. Four high-temperature magnetic remanent directions were isolated in French Guiana and the Ivory Coast. These directions are distinct from the present Earth's field and to the local Early Jurassic palaeomagnetic components. Reversal and contact tests were obtained for the collection from French Guiana. Based on these arguments and mineralogical investigations, we propose that the magnetic remanence represent a Palaeoproterozoic magnetization. Four virtual palaeomagnetic poles were calculated: GUI1, GUI2 for French Guiana; IC1 and IC2 for the Ivory Coast with their corresponding coordinates: GUI1: $\lambda_{\mathrm{GUI1}} = -62°$N, $\phi_{\mathrm{GUI1}} = 61°$E, $k = 18$, $A_{95} = 10°$, $N = 15$; GUI2: $\lambda_{\mathrm{GUI2}} = -5°$N, $\phi_{\mathrm{GUI2}} = 50°$E, $k = 26$, $A_{95} = 18°$, $N = 5$; IC1: $\lambda_{\mathrm{IC1}} = -82°$N, $\phi_{\mathrm{IC1}} = 292°$N, $k = 28$, $A_{95} = 13°$, $N = 6$; IC2: $\lambda_{\mathrm{IC2}} = -25°$N, $\phi_{\mathrm{IC2}} = 83°$E, $k = 11$, $A_{95} = 16°$, $N = 9$. The magnetization age ranged from 2.04 to 1.97 Ga for the French Guiana poles (^{40}Ar/^{39}Ar) and between 2.10 to 2.00 Ga for the Ivory Coast poles (startigraphic ages). Combining these new palaeomagnetic poles and previously published data, two apparent polar wander paths were proposed for these two shields. The comparison of these two Palaeoproterozoic paths seems to indicate that the two cratons belonged to the same block at about 2.00 Ga but separated prior to 2.02 Ga. Although this hypothesis is supported by geological and tectonic observations in both shields, further palaeomagnetic, geochronological and petrographic constraints are needs between 2.04 and 2.10 Ga.

Key words: APW, French Guiana, Ivory Coast, palaeomagnetism, Palaeoproterozoic.

1 INTRODUCTION

French Guiana and the Ivory Coast, part of the Guiana and West African Shield, are composed of Palaeoproterozoic (2.20–2.00 Ga) greenstone belts and granites, which are chemically and petrographically comparable (Ledru *et al.* 1994). Geochronology (Milési *et al.* 1995) and palaeomagnetic data (Piper 1982; Onstott & Hargraves 1981; Onstott *et al.* 1984) indicate that these two shields could have been composed of a single block ~2.0 Ga. This block may correspond to the first stage in the formation of the Palaeoproterozoic supercontinent, which was totally formed at 1.80 Ga (Condie 1998, 2000). This first stage corresponds to the Transamazonian and Eburnean tectonothermal events.

Previous palaeomagnetic and geochronologic investigations in these two cratons (Onstott *et al.* 1984; Onstott & Dorbor 1987; Nomade *et al.* 2001) and in other Palaeoproterozoic shields such as the Fennoscandian (Torsvik & Meert 1995; Fedotova *et al.* 1999) and North American cratons (Buchan *et al.* 1996), have shown that the primary magnetization can be preserved in Palaeoproterozoic rocks and could therefore provide information on the Palaeoproterozoic palaeogeography and geodynamics. Unfortunately, few geochronologic and palaeomagnetic data are available from either the Guiana or West African Shields. Until more data become available, the present situation does not permit one to build sufficiently precise apparent polar wander paths (APWPs) to constrain the timing of the block grouping.

To increase the Palaeoproterozoic palaeomagnetic database and contribute to the understanding of the Palaeoproterozoic palaeogeography and geodynamics; a multidisciplinary study (palaeomagnetism, $^{40}Ar/^{39}Ar$ thermochronology and petrography) was carried out in French Guiana (South America) and the Ivory Coast (West Africa). The fieldwork was supported by the French Geological Survey (BRGM) geological mapping project (Delor *et al.* 2001) and by the Ivory Coast's Ministère des Mines. The $^{40}Ar/^{39}Ar$ geochronologic results from French Guiana have been discussed in Nomade *et al.* (2002). Here, we report the petrographic and palaeomagnetic data from 59 sites (33 from French Guiana and 26 from the Ivory Coast).

2 GEOLOGICAL SETTING AND SAMPLING LOCATIONS

2.1 French Guiana

2.1.1 Geological setting

French Guiana, located in the northeastern part of the Guiana Shield (Fig. 1a), is composed of granite plutons and greenstone belts accreted during the Transamazonian tectonothermal event (2.20–2.00 Ga; Milési *et al.* 1995; Delor *et al.* 2001). The lithologic succession was studied by many authors (e.g. Choubert 1974; Milési *et al.* 1995; Vanderhaeghe *et al.* 1998; Delor *et al.* 2001). The basement is composed of the Paramaca greenstone belt sequence (Fig. 1b), consisting of volcanic rocks of tholeiitic and calc-alkaline compositions (Egal *et al.* 1995; Milési *et al.* 1995) and dated at 2.110 ± 0.090 Ga (Sm/Nd age, Gruau *et al.* 1985). These volcanic rocks are covered by the sedimentary deposits of Armina (Fig. 1b, Ledru *et al.* 1991) for which a minimum age of 2.13 Ga is proposed (Delor *et al.* 2001). Two periods of plutonism are recognized between 2.22 and 2.08 Ga (Milési *et al.* 1995). The first period (2.20–2.13 Ga) corresponds to large batholiths of tonalitic, trondjhemitic or granodioritic composition (TTG) (Milési *et al.* 1995; Vanderhaeghe *et al.* 1998). The second period corresponds to small granite and gabbro plutons (2.10–2.08 Ga; Vanderhaeghe *et al.* 1998). The earlier formation is composed of quartz-rich conglomerate and sandstone deposited in transcurrent basins (Egal *et al.* 1992, Fig. 1b). The structural evolution is divided into two events (D_1 and D_2; Vanderhaeghe *et al.* 1998). The D_1 deformation is contemporaneous with the TTG emplacement and D_2 corresponds to a NE–SW shortening event responsible for the major NW–SE sinistral strike-slip faults observed in French Guiana (Fig. 1b) (Vanderhaeghe *et al.* 1998). This D_2 event is dated from 2.11 to 2.09 Ga (Vanderhaeghe *et al.* 1998). $^{40}Ar/^{39}Ar$ ages along the Oyapok river (Nomade *et al.* 2002) suggests uniform slow cooling rates without significant vertical movement (3–6 °C Myr^{-1}) at medium to low temperatures (*ca.* 550–250 °C) after the D_2 event (Nomade *et al.* 2002).

2.1.2 Palaeomagnetic sampling

Two zones were sampled in French Guiana (Fig. 1b).

(1) Along the Oyapok river, two large batholithic zones are recognized: the central granitic complex (CGC) and the southern granitic complex (SGC). These two zones are separated by the southern greenstone belt (SGB), which is composed of metavolcanic and metasedimentary rocks. Previous palaeomagnetic investigations have shown that no reliable magnetic component was isolated from the metasediments (Nomade *et al.* 2001). A total of 27 sites were sampled along the Oyapok river, mainly in granitic rocks.

(2) Along the Maronie and Mana rivers (NGB) the outcrops are mainly composed of metasediments which show an N130°–N155° subvertical foliation and N120°–N130°-trending, 40°NE-dipping folds. The metamorphism and deformation were due to the emplacement of granitic plutons (Egal *et al.* 1992). Four sites of biotite-garnet metagreywacke (sites 11–14) and two sites of staurolite-biotite-garnet metapelites (sites 16–18) were sampled (Table 1). An age of 1.964 ± 0.004 Ga ($^{40}Ar/^{39}Ar$ age on biotite; plateau age on 79 per cent of ^{39}Ar released, Nomade 2001), was obtained from one granite along the Mana river. This age is consistent with the biotites cooling ages obtained for the rocks along the Oyapok river (Nomade *et al.* 2002), indicating a similar cooling history in the northern and southeastern part of French Guiana.

2.2 The Ivory Coast

2.2.1 Geological setting

The geology of the Ivory Coast, being part of the West African Shield (Fig. 2a), is divided into two domains: the western Archaean domain (the Kénéma-Man domain) and the eastern Palaeoproterozoic domain (Fig. 2a). Accurate age and lithostratigraphic descriptions of the Ivory Coast are given by Abouchani (1990), Pouclet *et al.* (1996) and Doumbia *et al.* (1998). The basement is mainly of tholeiitic greenstones emplaced in an oceanic context (Doumbia *et al.* 1998). Later TTG-type pluton emplacements (2.22–2.15 Ga) are responsible for the penetrative foliation observed in the greenstone belts. After this tectono-plutonic event the Comoé sedimentary basin formed (2.11–2.07 Ga; Fig. 2b, Vidal *et al.* 1996) with associated calc-alkaline volcanic activity (Doumbia *et al.* 1998). This opening was followed by a NW–SE shortening event (D_2) responsible for sinistral transcurrent N–S to NNE–SSW strike-slip faulting (Fig. 2b; Vidal *et al.* 1996). The Ferké batholith (2.094 ± 0.006 Ga U/Pb; Doumbia *et al.* 1998) and small bodies of granites (2.006 ± 0.048 to 2.065 ± 0.029 Ga of Rb/Sr whole rock; Delor *et al.* 1992) were emplaced during the transcurrent faulting (Vidal *et al.* 1996).

2.2.2 Palaeomagnetic sampling

The Ferké batholith is a significant granitic mass in the West Africa Shield (500 × 50 km^2; Fig. 2b). Studies of the petrography, tectonics and anisotropy of the magnetic susceptibility indicate that the batholith is composed of numerous small granitic plugs (Doumbia *et al.* 1998; Ouattara 1999; Nomade 2001). Deformation is concentrated in contact zones between the batholith and the country rock or between the small granitic bodies. 15 sites were sampled far from these deformed contact zones (Table 2).

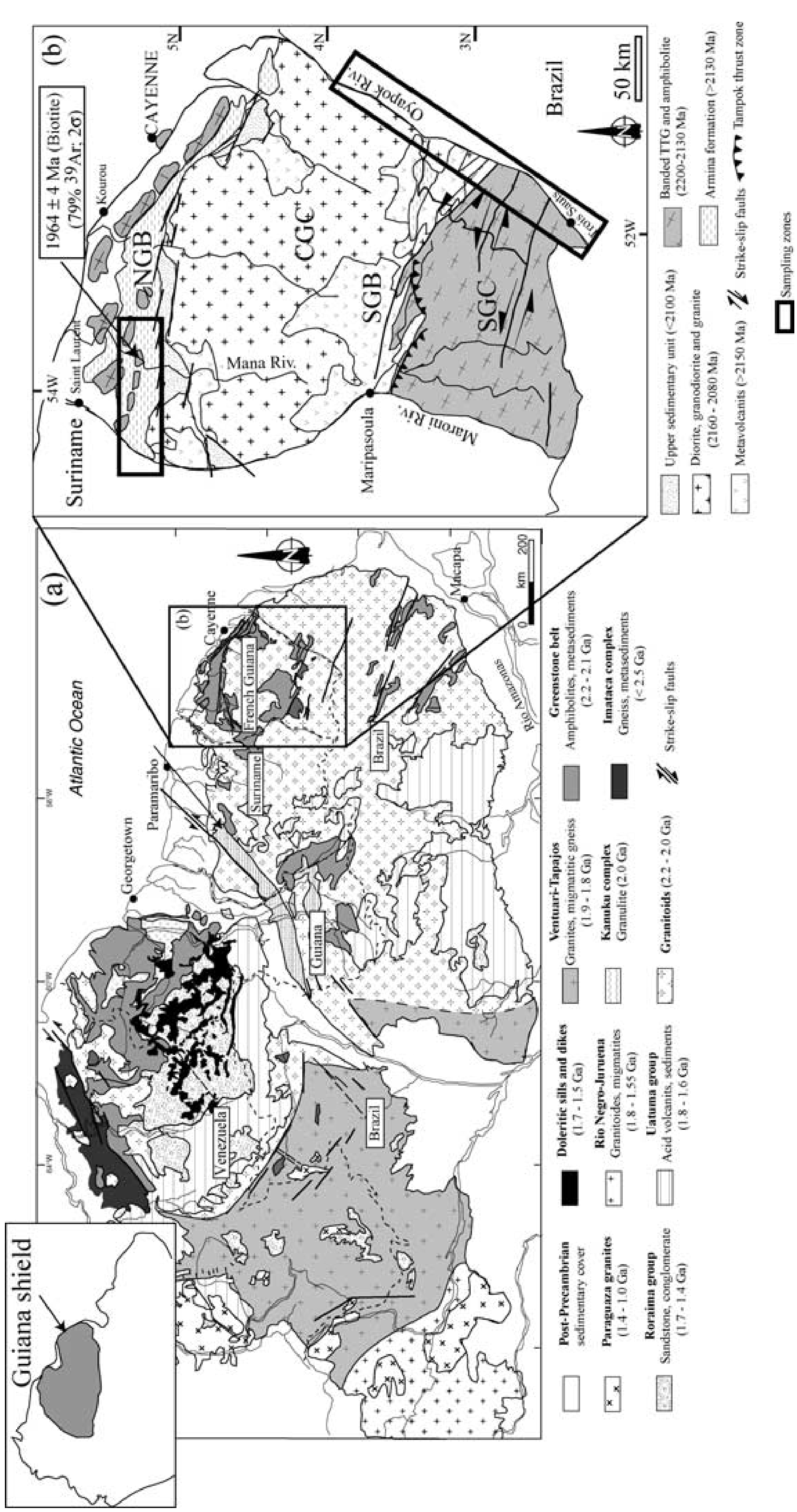

Figure 1. (a) Simplified geological map of the Guiana Shield (after Gibbs & Baron C.N. 1993); (b) Schematic geological map of the French Guiana (Ledru *et al.* 1991) and the location of the study zones.

Ten sites were sampled in TTG plutons in the Katiola region (sites 16–18), in the Fronan granite (site 20) and in the basement of the Comoé Basin (sites 21–26; Table 2) and one site was sampled in a rhyolitic dome (site 19) located in the Fétékro volcanic basin (Fig. 2b).

In both French Guiana and the Ivory Coast, six to eight cores were drilled at each site. The core orientation was measured by magnetic and, whenever possible, solar compasses. The average of differences between these two measurements is about $2^\circ \pm 1^\circ$. This correction was applied to the cores, which have only magnetic orientations. Cores were cut to standard size (2.54/2.2 cm), yielding 350 specimens.

3 CONTACT TEST AND MAGNETIC MINERALOGY STUDY

Magnetic memory depends on the age, the type and size of the magnetic mineral as well as the tectonic and thermal events that have occurred since the rock formed. To determine the primary character of the remanence, the influence of tectonic and thermal events need to be understood. These investigations involved magnetic mineralogical studies as well as physical properties, paragenesis, shape and chemical composition of the magnetic(s) carrier(s).

3.1 Contact test

The emplacement of numerous Jurassic basaltic dykes (related to the first stages of the central Atlantic opening) was the major thermal and tectonic event since the Palaeoproterozoic (e.g. Oliveira *et al.* 1990; Marzoli *et al.* 1999; Nomade *et al.* 2000). A study of the thermal influence of Jurassic dykes in the Cayenne zone on the Palaeoproterozoic host rocks (contact test) was carried out before the palaeomagnetic analysis. A detailed sampling was performed on several dykes with widths varying from a few metres up to 20 m and into adjacent country rocks. The space between samples ranges from centimetres to metres depending on the rock exposure. Fig. 3 shows the results from two dykes in northern French Guiana (widths of $\sim$10 and $\sim$20 m). Declination in the country rock shows similar directions to the dyke up to about 20 m from the border (Fig. 3a). Smaller dykes have a smaller influence on the country rock. The expected declination of the country rock is observed within a few centimetres of the dyke border (Fig. 3b). These observations are coherent with an inverse contact test, but also indicate that the thermal influence of the Jurassic dykes on the Palaeoproterozoic country rocks is of limited importance for small dykes ($<$10 m), which constitute about 90 per cent of the exposed dykes (Nomade *et al.* 2000). Nevertheless, we have sampled at least 2 m from all observed dykes in the sampling area.

3.2 Magnetic mineralogy study

In order to characterize magnetic mineral paragenesis, composition and form, we applied the following methods on representative samples: thermomagnetic experiments using a CS3 apparatus coupled with a KLY-3S kappabridge at the joint BRGM/Université d'Orléans Laboratoire de Magnétisme des Roches (LMR). Isothermal remanent magnetization was measured with an IM-10 impulse magnetizer and a JR5 spinner magnetometer. The latter was also used for remanent magnetization measurements. Hysteresis loops were measured on a translation inductiometer within an electromagnet providing a field of up to 1.5 T at the palaeomagnetic Laboratory of Saint-Maur (Paris); reflection microscopy observation (Olympus BX60) at the geological laboratory of Université d'Orléans; scanning electronic microscopy (SEM, JEOL) in Ecole Supérieure de l'Energie et des Matériaux (ESEM) in Orléans; and microprobe analysis (Camebax microbean) in the joint laboratory of CNRS-Université d'Orléans–BRGM.

3.2.1 French Guiana

3.2.1.1 Thermomagnetic and hysteresis curves

Representative thermomagnetic curves and hysteresis curves for the rocks from French Guiana are presented in Fig. 4.

Two types of thermomagnetic curves were obtained: (1) from the specimens ON1, PB1 and 13–99 which correspond to granitic rocks, amphibolite and metasediment the thermomagnetic curves display an important drop between 570 and 590 °C, characteristic of magnetite (Figs 4a–c); (2) the specimen PN1 (granite) displays a low susceptibility and a constant decrease of the magnetic susceptibility during heating (Fig. 4d). Such a curve is characteristic of a very low concentration or a lack of ferromagnetic material. Hysteresis loops performed on granite and metasediment rocks are narrow-waisted, typical of multidomain (MD) magnetite grains (Figs 4e and f; Dunlop 1986; Raposo & D'Agrella-Filho 2000). Fig. 4(g) (amphibolite) displays a thicker waisted form, which is typical of pseudo-single domain (PSD) magnetite (Dunlop 1986). Some specimens from granite (e.g. PL, PN) present linear hysteresis curves (Fig. 4h), indicating the dominance of paramagnetic minerals.

3.2.1.2 Petrographic investigation and chemical composition

Petrographic investigations confirm the presence of euhedral to subhedral magnetite, varying in size from 40 to 75 μm (Figs 5a–c). However, in some granitic rocks (e.g. sites PL or PN), ilmenite is the principal ferri-oxide and no magnetite grain was observed. These observations are consistent with the thermomagnetic and hysteresis experiments. Microprobe analysis indicates that the magnetites are Ti-poor (0–3.5 wt per cent) consistent with the Curie points being near 580 °C (Figs 4a–c).

In general, the petrographic observations and magnetic experiments suggest that Ti-poor undeformed euhedral to subhedral magnetite is the principal magnetic mineral in granitic, amphibolite and metasedimentary rocks. However, about 20 per cent of the samples (particularly granites) show an absence or a very low concentration of any magnetic mineral (Table 1).

3.2.2 The Ivory Coast

3.2.2.1 Thermomagnetic, isothermal remanent magnetization and hysteresis curves

Thermomagnetic, isothermal remanent magnetization (IRM) and induced magnetization (hysteresis curves) experiments were performed on representative samples from the Ivory Coast (Fig. 6).

The thermomagnetic curves (Figs 6a–c) show a drop of magnetic susceptibility between 570 and 590 °C, characteristic of magnetite. Additionally some samples from the Katiola and S–E granites (Figs 6b and c) show a moderate drop of the magnetic susceptibility at 660 °C, owing to the presence of haematite. IRM and hysteresis curves confirm the presence of magnetite (saturation at less than 0.2 T; Figs 6d–f) and a probable contribution of haematite (no saturation up to 1.5 T; Fig. 6f). Hysteresis curves are a waisted form, which is typical of MD and PSD magnetite (Figs 6g–i; Dunlop

Table 1. Summary of palaeomagnetic results from French Guiana. Slat and slong: latitude and longitude of the sampling site; Dec., Inc.: declination, inclination; n/N: number of entry in statistics/number of treated specimens; λ, ϕ, k and A_{95}: latitude and longitude of the pole position, precision parameter and confidence interval at the 95 per cent level.

Site	Geographic slat	Position slong	n/N	D (deg)	I (deg)	λ (°N)	ϕ (°E)	k	A_{95} (deg)
Granite									
FV	51° 58′ 35″	3° 41′ 17″	4/6	323	−6	−52	29	15	21
FX	52° 31′ 30″	2° 39′ 59″							
			5/9	342	2	−77	32	31	12
FY	52° 31′ 11″	2° 40′ 42″							
OA	51° 57′ 23″	3° 43′ 19″	6/8	341	60	−49	104	21	11
OF	52° 28′ 31″	2° 47′ 03″				No stable magnetic remanence			
OJ	52° 32′ 28″	2° 39′ 15″	3/6	127	−22	−37	49	68	9
OL	52° 31′ 32″	2° 34′ 24″				Dispersed magnetic directions			
OM	52° 33′ 10″	2° 31′ 53″	3/6	339	−23	−67	3	9	32
ON	52° 33′ 38″	2° 31′ 07″	5/6	351	−1	−81	22	17	15
OO	52° 32′ 40″	2° 26′ 02″				Dispersed magnetic directions			
OP	52° 38′ 35″	2° 25′ 30″				Dispersed magnetic directions			
OQ	52° 40′ 25″	2° 20′ 55″	6/6	332	53	−50	89	82	9
PC	52° 54′ 37″	2° 11′ 20″	3/4	27	−18	61	61	59	16
PJ	52° 49′ 09″	2° 17′ 44″	3/6	141	−39	−47	68	180	9
PK	52° 31′ 20″	2° 46′ 21″				No stable magnetic remanence			
PL	52° 31′ 20″	2° 46′ 21″				No stable magnetic remanence			
PM	52° 31′ 20″	2° 46′ 21″				No stable magnetic remanence			
PN	52° 31′ 20″	2° 46′ 21″				No stable magnetic remanence			
Amphibolite									
PA	52° 52′ 23″	2° 14′ 55″	5/8	173	−57	−55	116	33	11
Metasediments									
11	54° 20′ 50″	5° 08′ 30″	3/6	344	14	−73	41	84	14
12	54° 21′ 05″	5° 08′ 19″	5/7	328	12	−58	38	19	18
13	54° 25′ 09″	5° 02′ 46″	4/8	335	31	−63	63	45	10
14	54° 25′ 08″	5° 02′ 41	3/7	330	30	−59	58	16	24
16	53° 36′ 34″	5° 18′ 27″	4/9	344	44	−64	90	16	20
18	53° 40′ 38″	5° 11′ 22″	4/7	327	19	−54	46	29	13
		Mean GUI1	$N = 16$			−62	61	18	10
Granite									
FS	51° 56′ 27″	3° 43′ 16″							
			5/8	287	14	−17	44	20	18
FT	51° 56′ 43″	3° 43′ 15″							
PJ2	52° 49′ 11″	2° 17′ 42″							
			3/6	80	−38	9	59	257	8
OR	52° 41′ 16″	2° 22′ 03″							
OS	52° 43′ 02″	2° 20′ 50″							
			10/18	89	−2	1	38	13	14
OT	52° 44′ 04″	2° 20′ 15″							
OI	52° 31′ 43″	2° 39′ 22″	3/5	277	4	−7	39	21	17
Amphibolite									
PB	52° 54′ 04″	2° 11′ 48″	5/9	103	−39	−12	59	13	22
		Mean GUI2	$N = 5$			−5	50	26	18

1986). Some samples of granite present hysteresis curves (Fig. 6j), dominated by paramagnetic minerals.

3.2.2.2 *Petrographic investigation and chemical composition*

In the Ivory Coast rocks, petrographic investigation confirms the presence of variable sized euhedral to anhedral magnetite grains (Figs 5d and e). Particularly in the TTG, the magnetite has been partially transformed to haematite (Figs 5e–f). Partially or totally altered magnetite (Fe_3O_4) into haematite (αFe_2O_3) is common in granitic rocks (Haggerty 1976) and has been interpreted as being the result of thermal perturbation (metamorphism) promoted by hydrothermal fluids (Lindsley 1976). Such destabilization of magnetite occurs at temperatures around 300–550 °C, depending on grain size (Haggerty 1976). In the northern part of the Ferké batholith and in some TTG, ilmenite is the principal ferri-oxide mineral and no magnetite grain has been observed. Chemical analyses revealed that the magnetite and haematite are low in Ti (0–4 wt per cent). Nevertheless, some Ti-rich magnetite and haematite (10–11 wt per cent) were observed in TTG.

The main magnetic remanent carriers in granitic rocks from the Ivory Coast are euhedral to anhedral poor Ti magnetites (sometimes) and haematites formed by magnetite destabilization (essentially in TTG). In some rocks, as in French Guiana, a total absence or a very low concentration of magnetic minerals produce poor palaeomagnetic results (Tables 1 and 2).

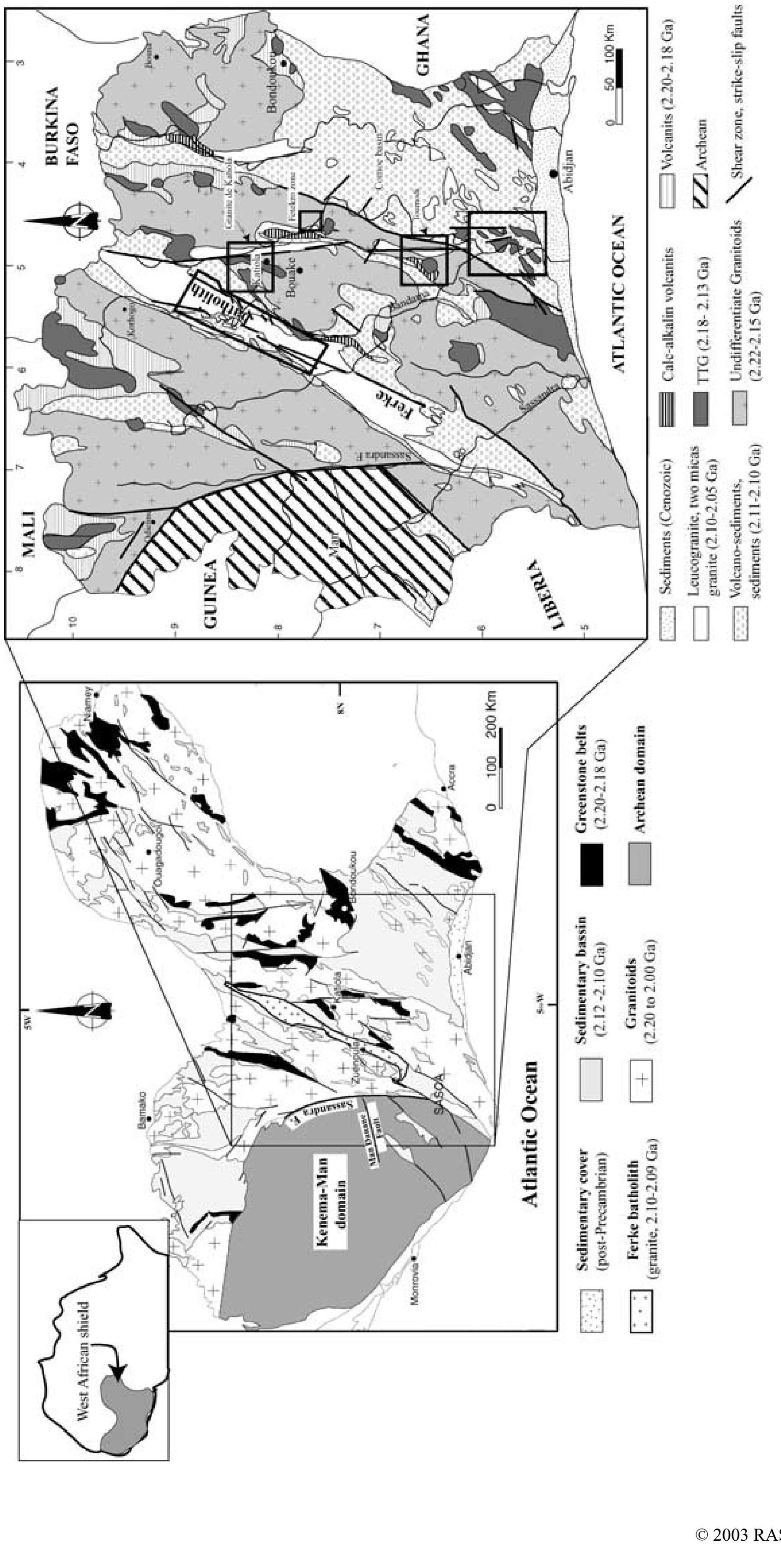

Figure 2. (a) Simplified geological map of the West African Shield (after Doumbia *et al.* 1998); (b) Schematic geological map of the Ivory Coast (after Ouattara 1999) and the location of the study zones.

Table 2. Summary of palaeomagnetic results of the Ivory Coast. See Table 1 for abbreviations.

Site	Geographic slat	Position slong	*n*/*N*	*D* (deg)	*I* (deg)	λ (°N)	ϕ (°E)	*k*	A_{95} (deg)
Ferke Batholith									
01	6° 15′ 47″	7° 00′ 44″	6/7	322	13	−52	85	36	11
02	6° 00′ 16″	7° 27′ 14″	6/7	314	15	−45	87	41	11
03	6° 00′ 04″	7° 27′ 21″	3/6	269	−1	1	84	9	32
04	5° 51′ 23″	7° 30′ 00″				No stable magnetic remanence			
05	6° 00′ 07″	7° 27′ 39″	3/6	305	17	−35	100	26	25
06	6° 00′ 05″	7° 27′ 49″				Dispersed magnetic directions			
07	5° 49′ 19″	7° 30′ 59″							
			6/12	287	30	−13	96	31	12
08	5° 46′ 50″	7° 32′ 30″							
09	5° 16′ 44″	8° 38′ 16″	3/7	277	−29	−5	66	29	23
10	5° 16′ 24″	8° 46′ 56″							
			5/12	297	−3	−26	78	13	26
11	5° 16′ 24″	8° 46′ 05″							
12	5° 16′ 07″	8° 46′ 58″				No stable magnetic remanence			
13	5° 14′ 43″	8° 46′ 52″	5/7	267	−2	3	84	22	17
14	5° 14′ 00″	8° 46′ 08″				No stable magnetic remanence			
15	5° 11′ 01″	8° 48′ 58″				No stable magnetic remanence			
19	4° 47′ 15′	7° 55′ 13″	3/6	326	−13	−53	63	46	19
		Mean IC2 (site)	9/16			−25	83	11	16
		Mean IC2 (sample)	40/70			−24	85	10	7
TTGs									
16	5° 04′ 23″	8° 11′ 15″	4/6	357	4	−83	19	120	9
17	5° 07′ 07″	8° 13′ 45″				Dispersed magnetic directions			
18	5° 06′ 57″	8° 14′ 08″				Dispersed magnetic directions			
20	6° 34′ 12″	5° 01′ 45″	4/7	19	1	−70	277	22	20
21	4° 40′ 18″	5° 53′ 24″	5/7	20	−9	−68	290	105	8
22	4° 41′ 17″	5° 54′ 18″	5/7	13	10	−83	276	28	15
23	4° 46′ 31″	5° 52′ 22″	3/6	345	26	−73	117	36	21
24	4° 40′ 50″	5° 49′ 01″				No stable magnetic remanence			
25	4° 40′ 52″	5° 48′ 40″				No stable magnetic remanence			
26	4° 35′ 20″	5° 42′ 23″	3/6	14	−10	−72	300	12	28
		Mean IC1 (site)	6/10			−82	292	28	13
		Mean IC1 (sample)	24/39			−77	281	20	6

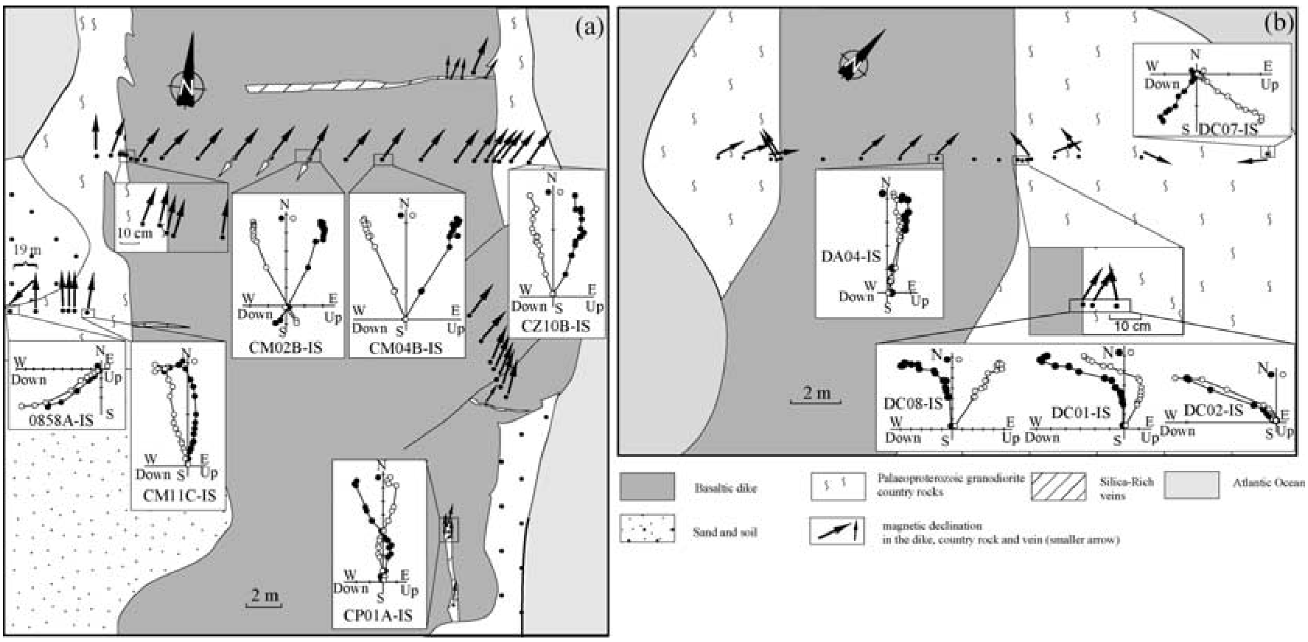

Figure 3. Magnetic declination in Jurassic diabase and Palaeoproterozoic granodiorite country rock and representive orthogonal diagrams (Zijderveld 1967) of progressive thermal demagnetization. From Gosselins (a) and Bourda (b) (Cayenne area, North-Eastern French Guiana). The closed (open) synbole refers to the horizontal (vertical) plane.

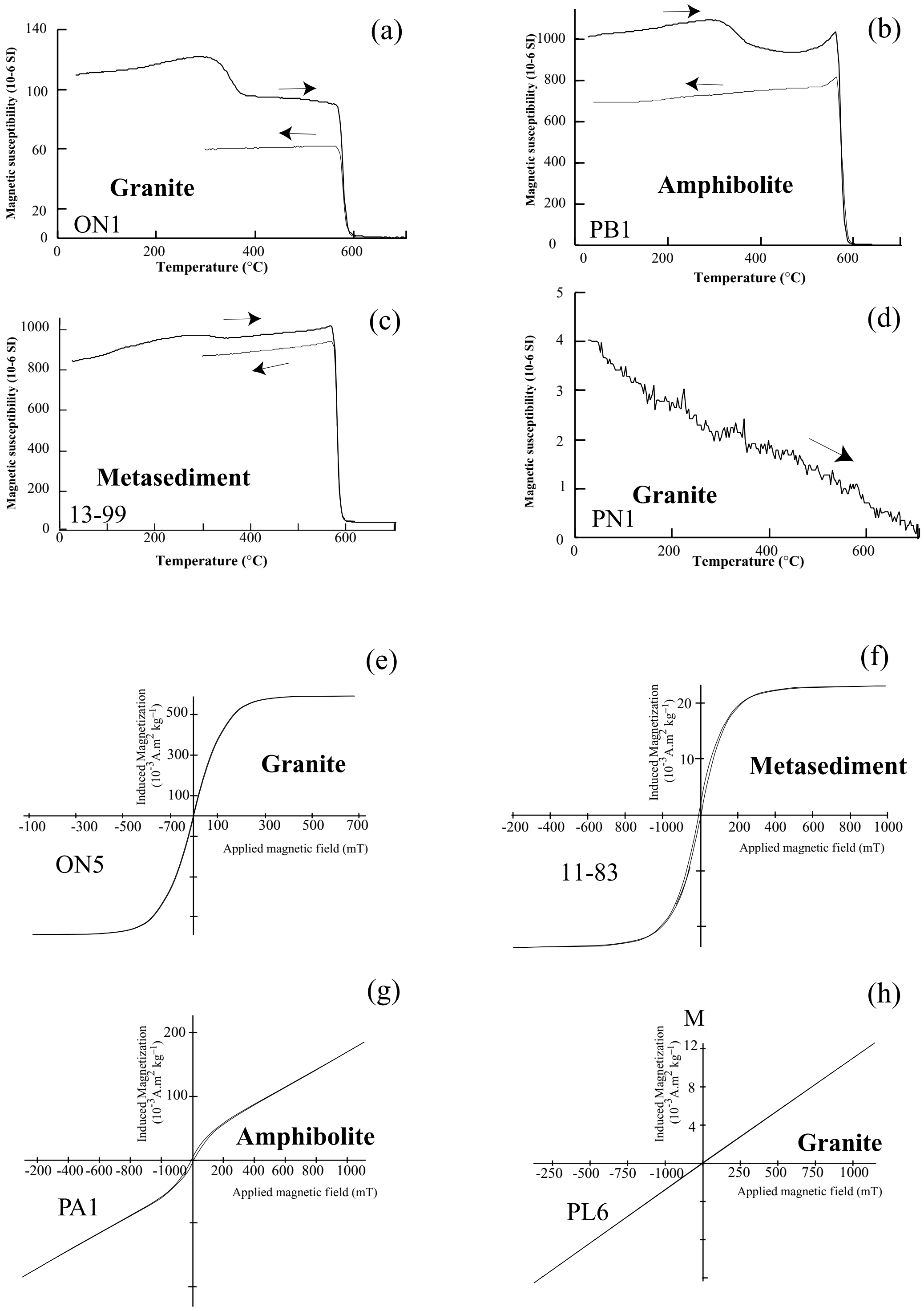

Figure 4. Typical curves of thermomagnetic experiments for granite (a), amphibolite (b), metasediment (c) and granite (d) rocks. Hysteresis curves performed on similar rocks showing narrow-waisted curves (e), (f), amphibolite (g) and granite rock showing a perfectly linear superposition of the two induced magnetic moment (h).

4 PALAEOMAGNETIC RESULTS

In French Guiana and the Ivory Coast more than 350 samples were analysed. Both thermal (Pyrox furnace) and alternating magnetic field (AF) techniques (automated three-axis tumbler AF demagnetizer; LDA-3, AGICO geofysica) were used for the magnetic cleaning. About nine (AF, 1–100 mT) to 14 (thermal, ∼20–695 °C) progressive steps were applied as a demagnetization procedure. The bulk susceptibility was measured after each heating step and indicated that

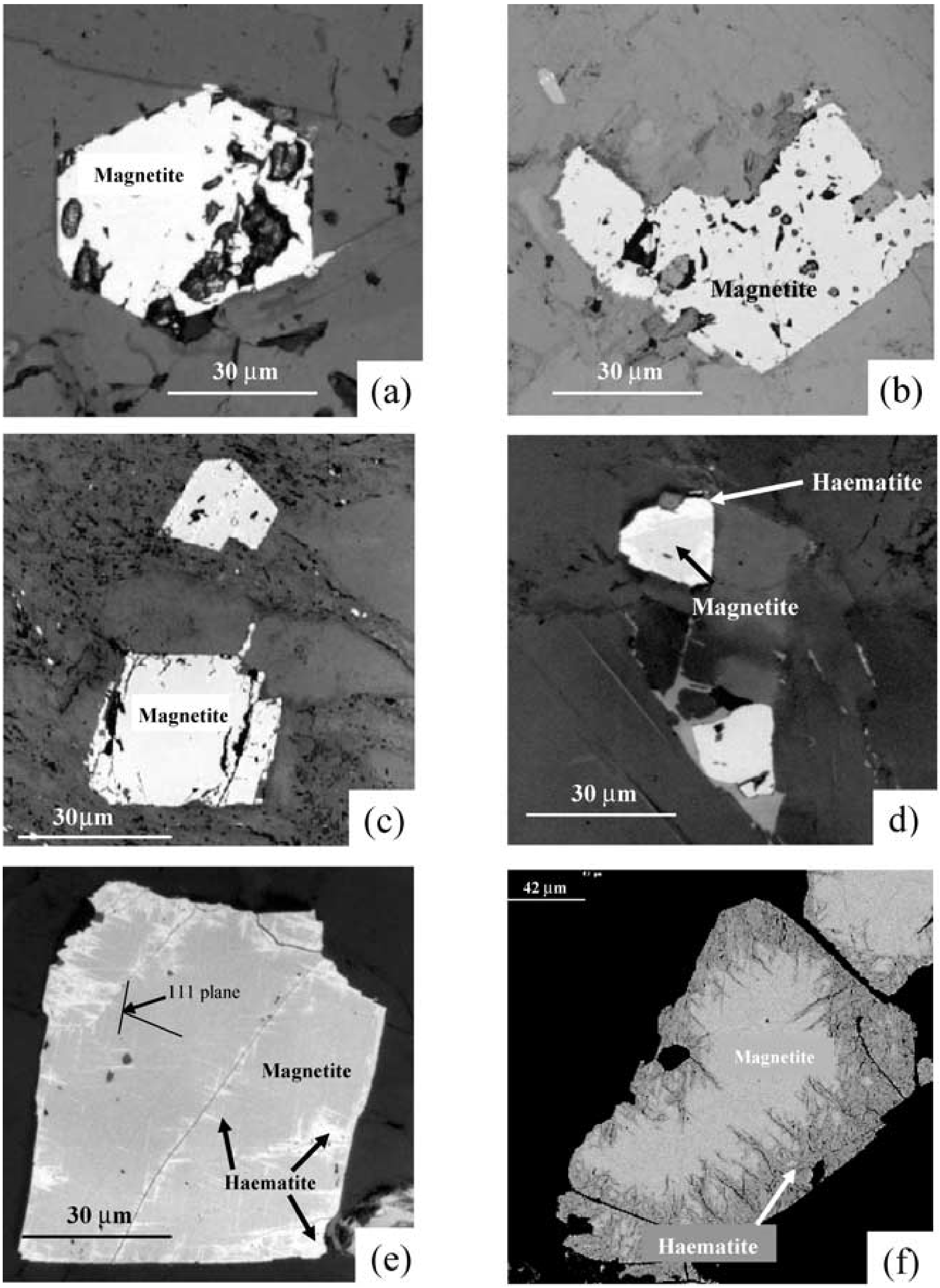

Figure 5. (a)–(e) Reflected light photographs of large euhedral to subhedral magnetite grains from French Guiana and the Ivory Coast sampled rocks. French Guiana: (a) granodiorite site ON (×200); (b) diorite (site OI, ×200); (c) metasediment, site 13 (×100), the Ivory Coast: (d)–(e) magnetite grains altering to haematite (sites 16 and 22, ×200); (f) Backscattered electron image (SEM) of crustal magnetite altering to haematite.

no important mineral transformation occurred during laboratory heating.

4.1 French Guiana palaeomagnetic results

The natural remanent magnetization (NRM) intensity depends on the mineralogical composition of rocks. The NRM varies from 5×10^{-5} to $5\ \mathrm{A\ m^{-1}}$ and from 1×10^{-5} to $5 \times 10^{-1}\ \mathrm{A\ m^{-1}}$ in granitic and metasediment samples. Granitic rocks show a bimodal distribution of NRM intensities. The lower intensity (5×10^{-5}–$5 \times 10^{-3}\ \mathrm{A\ m^{-1}}$) correspond to rocks with an absence or a low concentration of magnetic minerals. Other rocks (TTG) display higher NRM intensity ranging from 1×10^{-2} to $5\ \mathrm{A\ m^{-1}}$. NRM in amphibolitic rocks (sites PA and PB) is uniformly high (1×10^{-2} to $10\ \mathrm{A\ m^{-1}}$). Typical

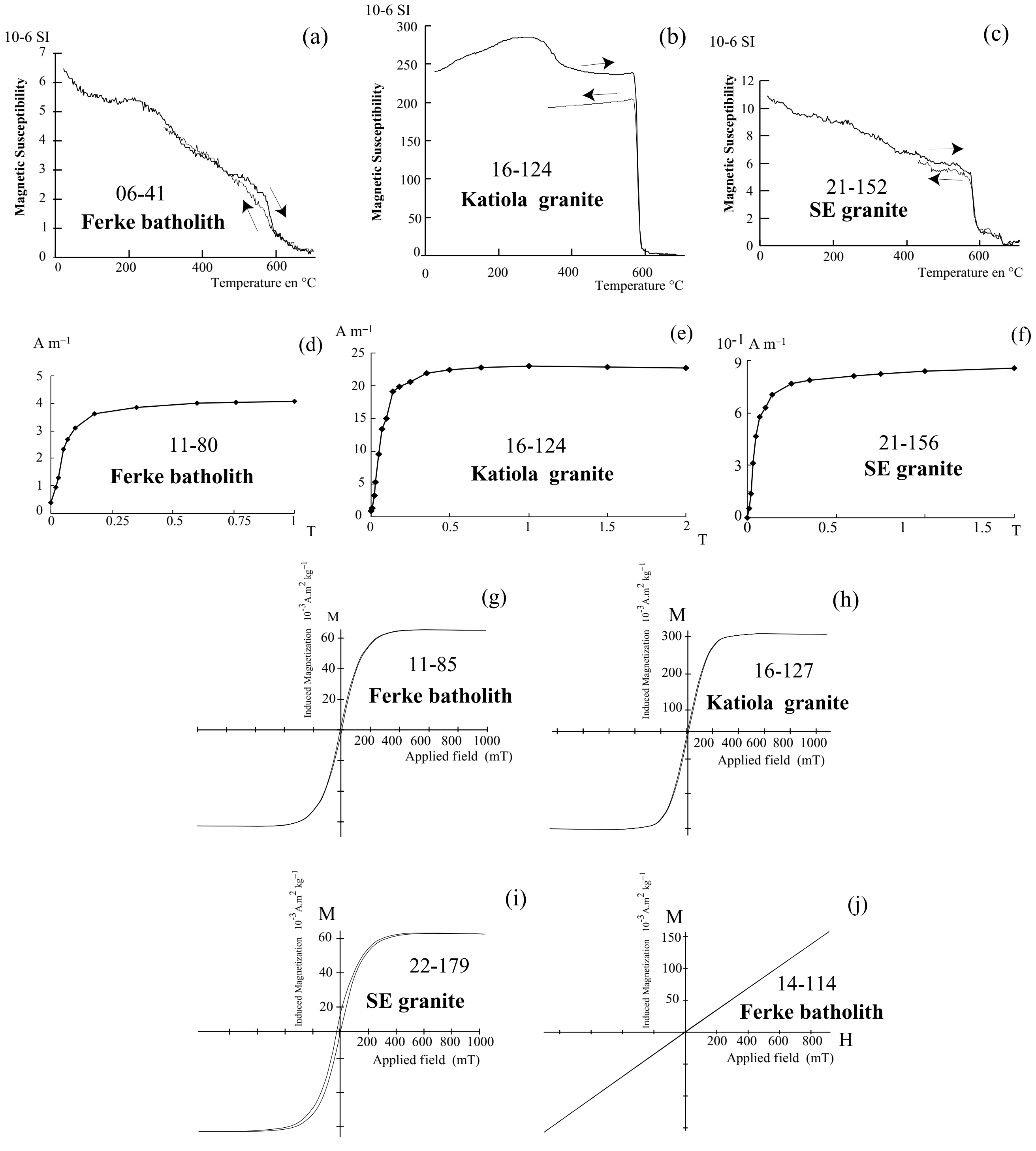

Figure 6. Typical curves of thermomagnetic experiments for Ferké batholith (a) and TTG (b), (c). Typical isothermal remanent magnetization (IRM) acquisition for Ferké batholith (c) and TTG (e), (f). Hysteresis curves performed showing a narrow-waisted curves in the Ferké batholith (g) and TTG (h), (i). Some samples display perfectly linear superposition of the two induced magnetic moments (j).

demagnetization responses, plotted in orthogonal vector endpoint diagrams (Zijderveld 1967) are presented in Fig. 7.

4.1.1 Granitic rocks

According to the magnetic directions, three groups are distinguished.

(1) A characteristic upward and downward inclination with SSE to NNW declination is obtained (Figs 7a and b; group A) after the removal of low-temperature directions (<250 °C). Unblocking temperatures vary from 525 to 570 °C, characteristic of magnetite. Two polarities are isolated. The site mean directions are described by an indeterminate class reversal test (McFadden & Lowes 1981; McFadden & McElhinny 1990 Fig. 7c).

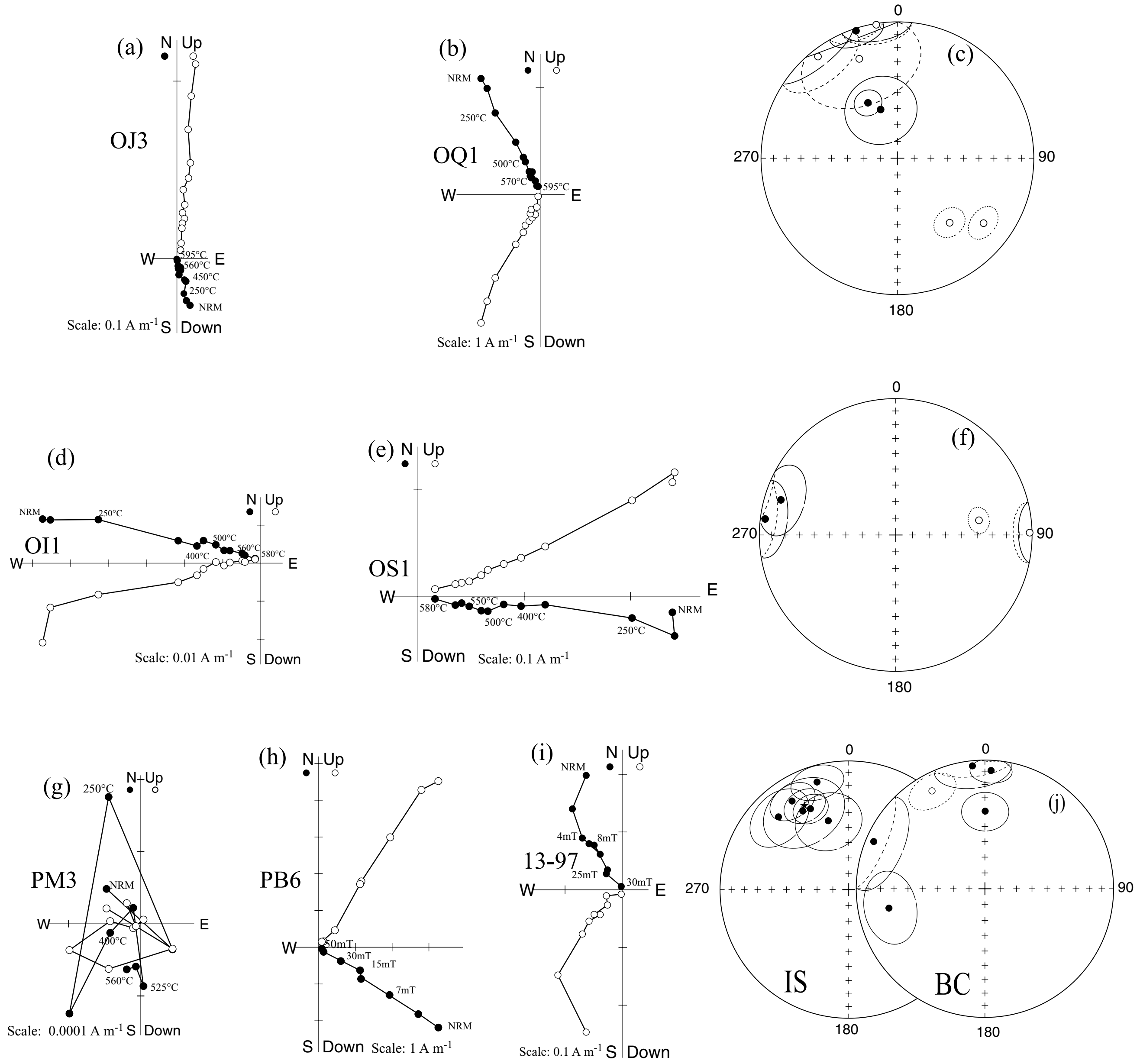

Figure 7. Results of magnetic studies of French Guiana samples. a–b–c, d–e–f and g–h demagnetization. The closed (open) symbol refers to the horizontal (vertical) projection. Equal area stereoplot of mean direction (c) group GUI1 and (f) group GUI2 showing normal and reverse direction (i). Representative orthogonal vector diagrams of alternating field demagnetizations of metasediments of French Guiana. (J) site mean direction before (IS) and after (BC) bedding and folding corrections.

(2) The second group corresponds to westward and eastward declination with shallow upward and downward inclination, respectively (Figs 7d–e; group B). Unblocking temperatures vary from 500 to 550 °C, typical of the mineral magnetite. These four sites present antipodal directions (Fig. 7f, the reversal test is indeterminate: McFadden & Lowes 1981; McFadden & McElhinny 1990).

(3) The last group are specimens that present no stable magnetic remanence (Fig. 7g; sites OF, PK, PL, PM, PN) or specimens show within site scattered directions (sites OO, OP, OL). In these later sites, an individual magnetic direction could be well defined but the distribution is not clustered. All of these sites will be excluded from the mean calculation and from the discussion. For the two first groups, the site mean direction is calculated and presented in Table 1. The sites, which correspond to the same pluton and/or are spatially closed were clustered before computing the site-mean direction (e.g. sites OR, OS, OT).

4.1.2 *Amphibolite and metasediments*

In the amphibolitic rocks (sites PA–PB) a single magnetic component dominated by upward inclination with northeastward declination (Fig. 7h) was isolated. Moderate coercitivity (Fig. 7h) indicate that the magnetic remanence is carried by magnetite. The site-mean directions are listed in Table 1.

In metasedimentary rocks, after the removal of a 'soft' magnetic component (<4 mT), the remanence decays linearly to the origin until 30 mT (Fig. 7i). The characteristic component is downward with a northwestward declination (Fig. 7i). Site-mean directions are presented in Fig. 7(j). The site-mean directions are better clustered in geographic coordinates (IS) than in stratigraphic ones (BC) this indicate a negative fold test ($K_{\mathrm{IS}}/K_{\mathrm{BC}} = 9.51$; McElhinny 1964).

Table 1 presents all the palaeomagnetic results obtained in French Guiana. The site-mean directions are distinct from both the present Earth's field and the local Jurassic dyke palaeomagnetic direction ($D = 8^\circ$, $I = -1^\circ$; Nomade *et al.* 2000). The Fisher statistical precision parameter (k) for each site-mean direction is usually greater than 10 (Table 1) and the two groups of granitic rock (GUI1, GUI2) present clustered magnetic directions. Concerning the metasediments, which display a negative fold test, investigations carried out in the same region indicate that the structures and the metamorphism (3–4 Kbars and 500–600 °C) are the result of granitic pluton emplacement (Choubert 1974; Egal *et al.* 1992, 1995). This suggests that the sedimentary units were remagnetized by this thermal event.

The above observations and the fact that the magnetic remanent carrier was clearly identified: unaltered and undeformed euhedral to subhedral Ti-poor magnetite (see Sections 3.1.1 and 3.1.2 above); suggest that the magnetic remanence is of primary origin for the granites and represent a Palaeoproterozoic magnetization for the metasediment. Since the palaeomagnetic sites were sampled over a large geographic area (Fig. 1), the site-mean directions were calculated as virtual poles (VGP) as the basis for calculating the mean poles (Table 1; Fig. 8). The distribution of all poles, except that of site PC, may be divided into two groups (Fig. 8). Pole PC is far away from all others and close to the Jurassic pole (Nomade *et al.* 2000), therefore it was excluded from the mean pole calculations. Two mean poles named GUI1 and GUI2 were calculated: pole GUI1: $\lambda_{\mathrm{GUI1}} = -62^\circ$N, $\phi_{\mathrm{GUI1}} = 61^\circ$E, $k = 18$, $A_{95} = 10^\circ$, $N = 16$ and pole GUI2: $\lambda_{\mathrm{GUI2}} = -5^\circ$N, $\phi_{\mathrm{GUI2}} = 50^\circ$E, $k = 26$, $A_{95} = 18^\circ$, $N = 5$. The ages of the magnetic remanence will be discussed in Section 5.1.

4.2 The Ivory Coast palaeomagnetic results

A bimodal distribution of the NRM intensity has been observed for the Ferké Batholith samples: low to medium NRM intensity group (5×10^{-5}–1×10^{-2} A m^{-1}) and a higher NRM intensity group (5×10^{-2}–5 A m^{-1}). Such a variation is probably due to the heterogeneity of mineralogical compositions among the small plutons within this batholith. The other rocks (TTG and rhyolite) present a relatively high NRM intensity from 5×10^{-3} to 5 A m^{-1}. The typical demagnetization responses are plotted in orthogonal diagrams (Zijderveld 1967).

4.2.1 Ferké batholith

After demagnetization, three directional groups could be distinguished.

(1) In the first group the majority display only one component (Fig. 9a) and few specimens present two components (Fig. 9b). The low-temperature component (NRM to 450 °C) is scattered. The high-temperature direction is clustered and displays a downward inclination and northwestward declination (Figs 9a and b). The unblocking temperatures vary from 500 to 620 °C, which is characteristic of magnetite and haematite. The petrographic investigation shows that haematite was formed by oxidation of magnetite (>400 °C). The fact that the two magnetic carriers show a consistent direction may be due to a rapid alteration (fluid percolation) soon after crystallization or a total remagnetization. A rapid alteration of the magnetite after the crystallization is more probable, because the small plutons accretion is associated with fluid percolation (Ouattara 1999). Moreover, there has been no thermal event in the West African Shield since emplacement of the Ferké batholith (2.10–2.09 Ga; Pouclet *et al.* 1996; Vidal *et al.* 1996; Doumbia *et al.* 1998).

(2) The second group corresponds to a shallow downward inclination with east to southeastward declination (Fig. 9c). This component is observed in the northern part of the batholith (sites 9–13; Table 2). The orthogonal diagrams indicate that the remanent magnetic direction is probably carried by magnetite with unblocking temperatures varying from 525 to 560 °C.

(3) The third group has very chaotic magnetic directions (Fig. 9d; sites 4, 12, 14, 15; Table 2) or dispersed magnetic directions in the site (site 06; Table 2). Most of these sites have relatively low NRM intensity (5×10^{-5}–5×10^{-3} A m^{-1}). No ferromagnetic minerals were observed microscopically in these rocks.

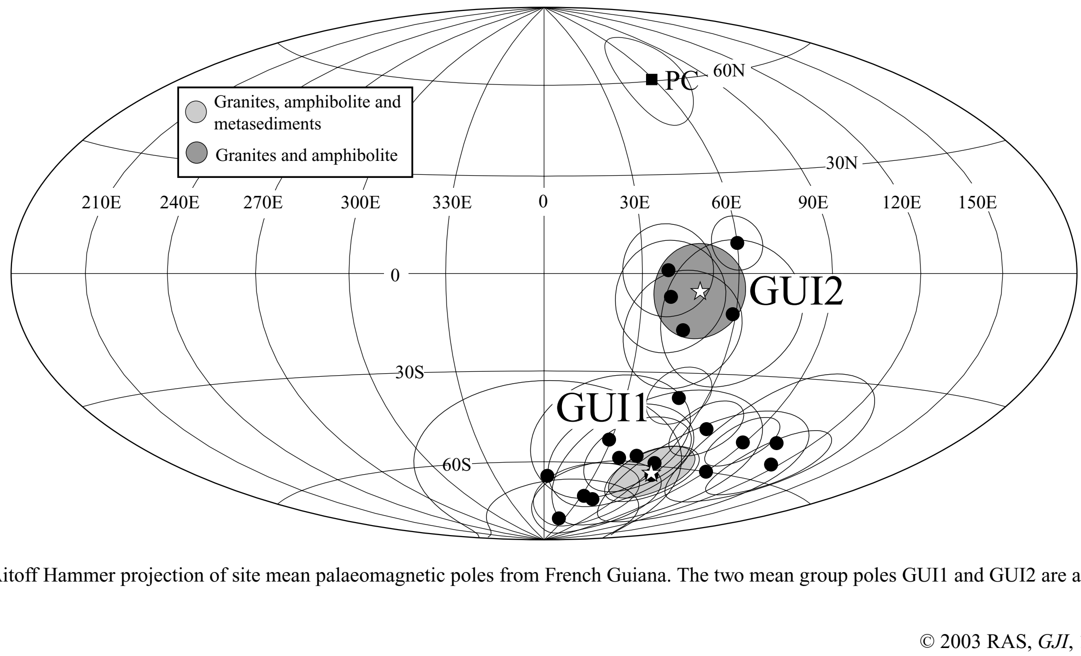

Figure 8. Aitoff Hammer projection of site mean palaeomagnetic poles from French Guiana. The two mean group poles GUI1 and GUI2 are also indicated.

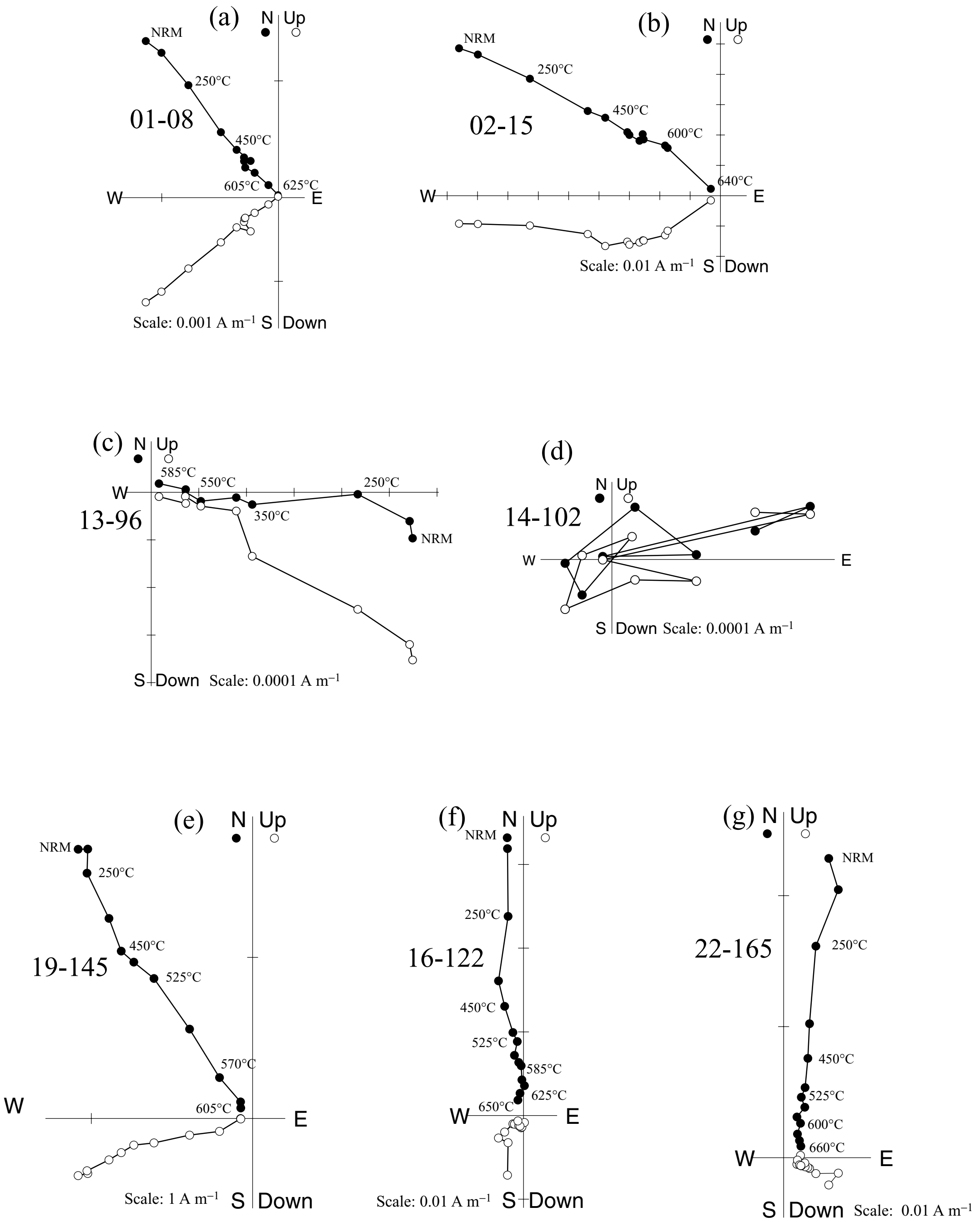

Figure 9. Representative orthogonal vector diagrams of progressive thermal demagnetization from samples of the Ferké batholith (a)–(e) and from the TTG (f)–(g). The closed (open) symbol refers to the horizontal (vertical) projection.

For the first two groups, the site-mean directions are presented in Table 2. Sites 7–8 and 10–11, corresponding to the same pluton, are clustered (Table 2).

4.2.2 TTG and the rhyolite

Three magnetic behaviours could be distinguished.

(1) The rhyolite (site 19) displays, at high temperature, a downward inclination and northwestward declination (Fig. 9e).

(2) The TTGs of the northern zone (sites 16 and 20) and granites from the basement of the Comoé basin (sites 21–23 and 26) display downward inclinations with NNE to NNW declination (Figs 9f and g).

(3) The third group corresponds to the TTG of sites 17–18 and 24–25 (two mica granites), which present dispersed magnetic directions or an absence of magnetic remanence (Table 2).

In the first two groups the unblocking temperatures vary from 500 to 660 °C. Such temperatures correspond to both magnetite and haematite, which were observed in polished sections. Site mean directions are presented in Table 2.

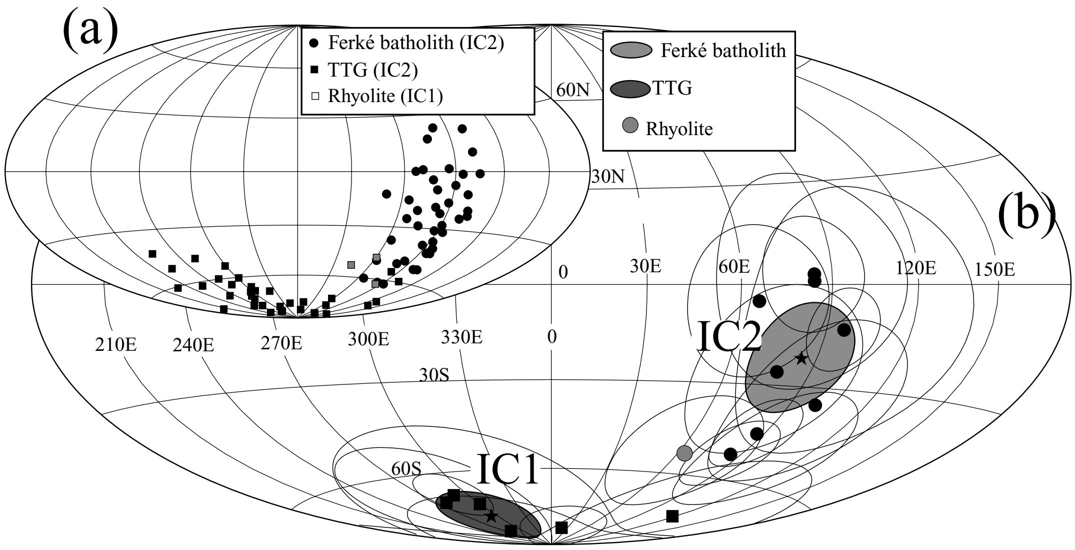

Figure 10. The Ivory Coast palaeomagnetic poles (a) specimen poles (b) site mean poles. The two mean group poles are IC1 and IC2.

As for the French Guiana sites, the Ivory Coast results will be computed as VGPs and mean poles (Table 2; Fig. 10). Fig. 10(a) presents the palaeomagnetic poles calculated for each specimen. Poles show a longitudinal distribution between 60–100°E and 270–330°E (Fig. 10). Two grouping of poles correspond to the TTGs (IC1) and to the Ferké batholith (IC2) (IC1: $\lambda_{IC1} = -82°N$, $\phi_{IC1} = 292°N$, $k = 28$, $A_{95} = 13°$, $N = 6$; IC2: $\lambda_{IC2} = -25°N$, $\phi_{IC2} = 83°E$, $k = 11$, $A_{95} = 16°$, $N = 9$). The palaeomagnetic pole of site 19 (rhyolite) has an intermediate position between the poles IC1 and IC2 (Figs 10a and b).

5 DISCUSSION

5.1 Magnetic remanence ages and APWPs of Guiana and West African Shields

The palaeomagnetic poles obtained in this study and previous studies of the Guiana and the West African Shield for the Palaeoproterozoic period are listed in Table 3 and presented in Fig. 11. Seven poles are now available for the Palaeoproterozoic in the Guiana Shield and nine for the West African Shield.

5.1.1 Guiana Shield APWP

Nomade *et al.* (2001, 2002) have discussed the $^{40}Ar/^{39}Ar$ investigation on the Oyapock river. Using those cooling rates (2–6 °C Myr^{-1}) and the magnetic remanence blocking temperatures obtained in this study we have estimated the remanence magnetization age: pole GUI1 at 2.014 ± 0.027 Ga; pole GUI2 at 1.993 ± 0.025 Ga. For the pole OYA an age of 2.036 ± 0.014 Ga was proposed by Nomade *et al.* (2001). Pole A is slightly distinct from the poles obtained from Venezuela (Onstott & Hargraves 1981; Onstott *et al.* 1984) (Fig. 11a) with an estimated age range of 2.04–1.90 Ga (Fig. 11a). We propose an APWP for the Guiana Shield between 2.04 and 1.99 Ga shown in Fig. 11(a). This path indicates that the Guiana Shield had a latitudinal movement of 54° ± 16° between 2.04 and 2.01 Ga

Table 3. Available Palaeoproterozoic poles for the Guiana and West African Shields. A_{95}, λ and φ, k: confidence interval at the 95 per cent level, λ and φ latitude and longitude of the apparent pole position.

Rock type Guiana Shield	Locality	Country	A_{95} (deg)	λ °N	φ °E	Remanence age estimation (Ma)	Dating methods	References
Granite	La Encrucijada	Venezuela	6	−55	8	1900–2000	Ar/Ar (hornblende, biotite)	Onstott *et al.* (1984)
Granite	La Encrucijada	Venezuela	18	−37	36	1900–2000	Ar/Ar (hornblende, biotite)	Onstott *et al.* (1984)
Ganulite	Imataca	Venezuela	18	−49	18	1950–2050	Rb/Sr (isochron, whole rock)	Onstott & Hargraves (1981)
Ganulite	Imataca	Venezuela	18	−29	21	1950–2050	Rb/Sr (isochron, whole rock)	Onstott & Hargraves (1981)
Granite, metasediment		French Guiana	18	−5	50	1968–2017	Ar/Ar (hornblende, biotite)	This study
Granite, amphibolite		French Guiana	10	−62	61	1987–2041	Ar/Ar (hornblende, biotite)	This study
Tonalite	St-Joseph	French Guiana	14	−28	346	2022–2050	Ar/Ar (hornblende, biotite)	Nomade *et al.* (2001)
West African Shield								
Gabbro	Aftout	Algeria	6	29	55	1819–1919	Stratigraphy and Rb/Sr	Sabaté & Lomax (1975)
Amphibolite	Harper	Liberia	7	−10	73	1900–2000	Ar/Ar (hornblende, biotite)	Onstott *et al.* (1984)
Amphibolite	Harper	Liberia	7	−10	73	1900–2000	Ar/Ar (hornblende, biotite)	Onstott *et al.* (1984)
Granite	Aftout	Algeria	8	−6	90	1950–1982	Stratigraphy	Lomax (1975)
Granite	Ferke	The Ivory Coast	16	−25	83	∼2000	APWP, Pb/Pb (2094 ± 6 Ma)	This study
Granulite		Liberia	13	−18	89	2044–2056	Rb/Sr (isochron, whole rock)	Onstott & Dorbor (1987)
Dolerite	Abouasi	Ghana	11	−50	102	2000–2200	Stratigraphy	Piper & Lomax (1973)
Amphibolite	Abouasi	Ghana	14	−56	36	2100–2200	U/Pb	Piper & Lomax (1973)
Granite		The Ivory Coast	13	-82	292	2100-2070	Stratigraphy, thermal event	This study

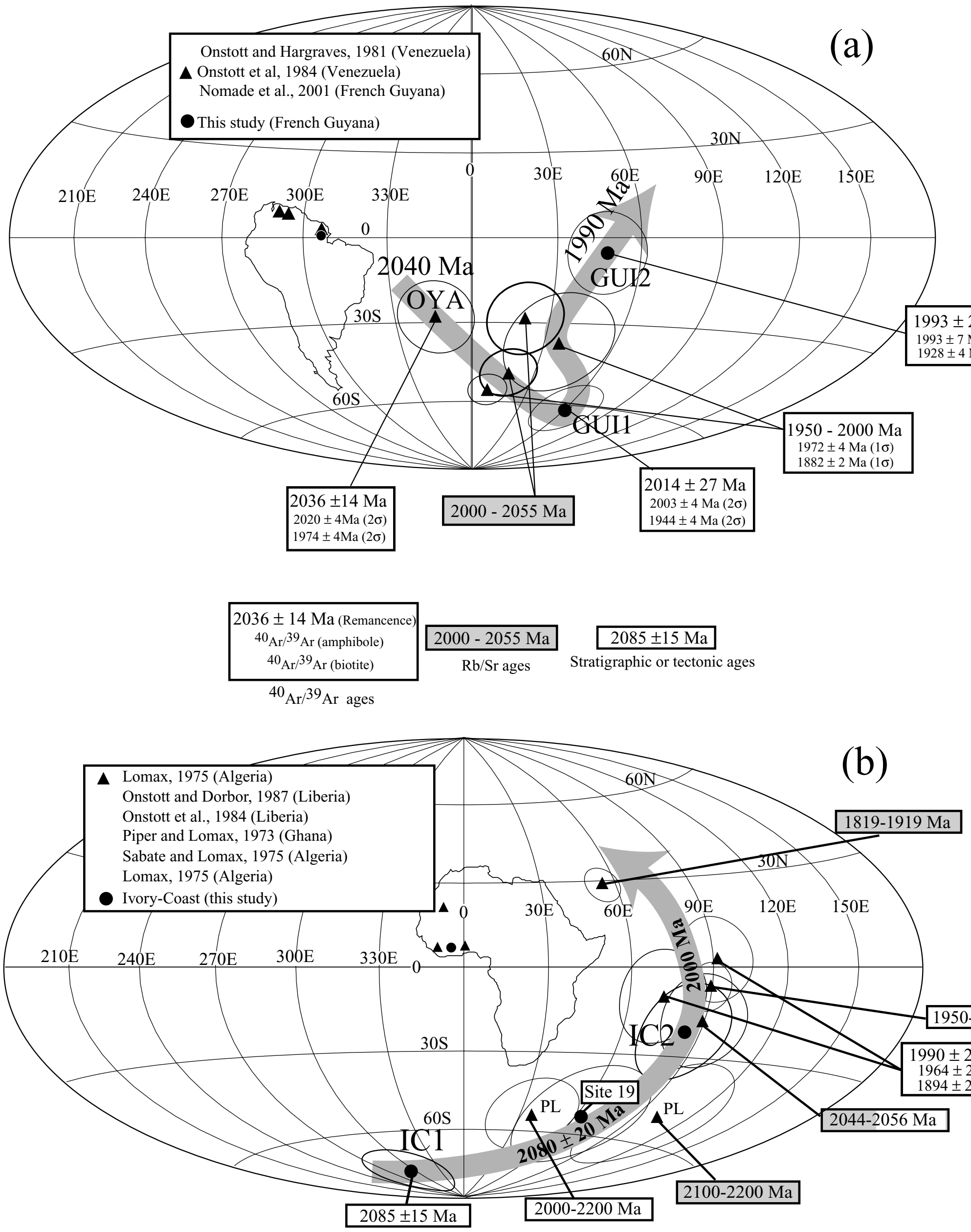

Figure 11. Palaeomagnetic poles from our study and previous studies (a) proposed APWP for the Guiana Shield between 2.05 to 1.97 Ga and (b) the West African Shield (2.10–1.90 Ga). Estimation of the age of the magnetic remanence acquisition for poles are also indicated.

and counter-clockwise rotational movement ($58^\circ \pm 24^\circ$) between 2.01 and 1.99 Ga. The $54^\circ \pm 16^\circ$ latitudinal and $58^\circ \pm 24$ rotational movement correspond to a mean plate velocity of 20 and 30 cm yr^{-1}, respectively. We propose that this fast plate velocity (two to three times more important than the actual plate velocity) could be explained by more important mantle convection 2.0 Gyr ago.

5.1.2 East-African Shield APWP

Fig. 11(b) presents palaeomagnetic data from this and previous studies. The Palaeoproterozoic poles show a longitudinal distribution. $^{40}Ar/^{39}Ar$ dating was lacking in our palaeomagnetic study, so we will estimate the ages of the magnetic remanence from lithostratigraphic correlation and previous published works. Pole IC2 is near to three poles from Liberia (Onstott *et al.* 1984; Onstott & Dorbor 1987). The $^{40}Ar/^{39}Ar$ ages obtained by Onstott *et al.* (1984) allows us to propose an age of approximately 2.0 Ga for the magnetic remanence of pole IC2. Using the crystallization age of 2.094 ± 0.006 Ga (U/Pb) (Doumbia *et al.* 1998), provides a low cooling rate of about 3 °C Myr^{-1} (between 800 and 500 °C), which is consistent with the rate for the Palaeoproterozoic rocks from Liberia (Onstott *et al.* 1984). Two poles (PL, Piper & Lomax 1973) are located near to these palaeomagnetic results from rhyolite site 19 (Fig. 11b). The stratigraphic constraint on these rocks and previous dating obtained from rhyolites in the same region suggest an age of 2.10–2.06 Ga (Rb/Sr and U/Pb ages; Lemoine 1988; Leake 1992). We propose an age of 2.080 ± 0.020 Ga for the pole of site 19. Pole IC1 corresponds to rocks, which are older than the Ferké Batholith (2.22–2.15 Ga, U/Pb; Doumbia *et al.* 1998). Our mineralogical observations suggest

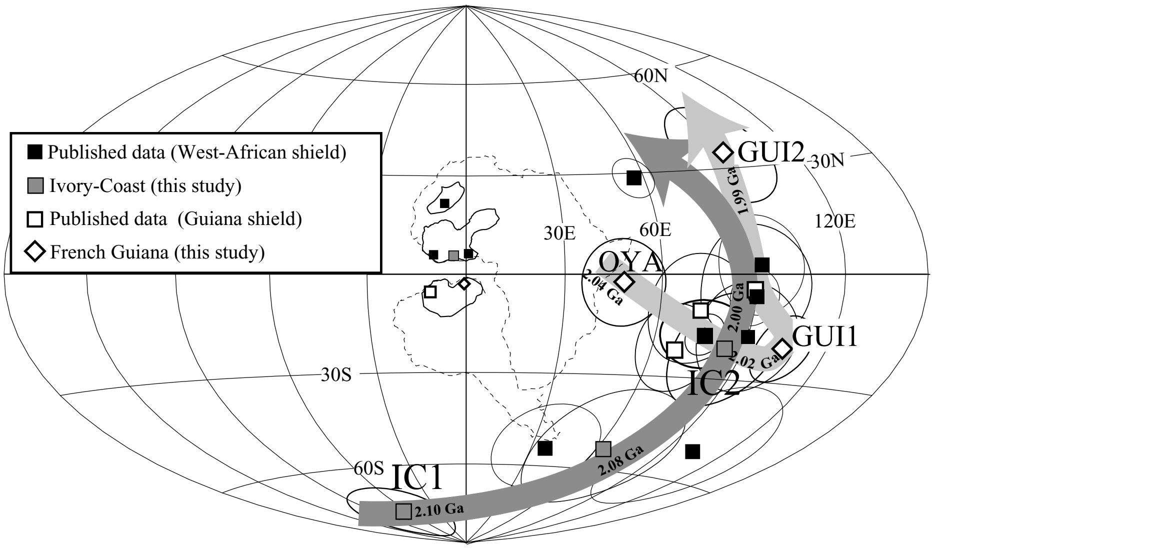

Figure 12. Two proposed APWPs, the Guiana Shield APWP is transferred to West Africa (Onstott & Hargraves 1981; Lawer & Scotese 1987). Prior to 2.02 Ga the poles from Guiana and West African Shields are not compatible (OYA, PL, IC1). At approximately 2.02 Ga the two curves crossed each over and follow a nearly parallel path.

that the TTGs suffered a regional scale hydrothermal event (transformation of the magnetite into haematite) and were magnetically reset. The only thermal event, which could be responsible for such a regional scale effect, was the NW–SE shortening event (D_2). Based on these arguments we propose an age of 2.085 ± 0.015 Ga for the pole IC1.

In general the APWP shows that the West Africa Shield has a counter-clockwise rotational motion of 70° ± 15° between 2.085 and 2.000 Ga, with little or no latitudinal changes (Fig. 11b).

5.2 Age of the block assembly?

To facilitate the comparison of the APWPs, the Guiana Shield palaeoproterozoic poles were transferred to an Africa frame using the rotational parameters of Onstott & Hargraves (1981, for the alignment of the major fault zones in both blocks) and Lawer & Scotese (1987, for Atlantic closure) (Fig. 12). Prior to 2.02 Ga the palaeomagnetic poles from the two cratons are distinct in position and age (poles OYA, IC1 and PL). Pole GUI1 (2.014 ± 0.027 Ga) of the Guiana Shield and pole IC2 (2.00 Ga) of the West African Shield are consistent in location and age. The poles younger than 2.00 Ga from both shields share a similar path. These observations suggest that the Guiana and the West African Shields were separated prior to 2.02 Ga; however, the two shields were a single block 2.00 Ga. It should be pointed out that this model is based on only one palaeomagnetic pole older than 2.02 Ga in French Guiana (pole OYA). No palaeomagnetic data are available in the interval 2.08 and 2.00 Ga for the West African Shield. An argument could be made that the longitudinal distribution of poles is the product of local rotations within the Ivory Coast block. However, the progressive change of pole positions from pole IC1 to pole IC2 issued from a large sampling area (Algeria, Ghana, Liberia and the Ivory Coast) and different types of rock suggest large block-scale motion and not a local movement (Figs 10a and b). Moreover, a similar polar distribution is observed in the previously published data concerning several western African zones (Liberia, Ghana and Algeria, Fig. 11). Moreover, the geological data highlight that the displacements along the major identified N–S strike-slip faults are generally small (e.g. region of Toumudi). Although there are only a limited number of poles, we can discuss some aspect of the palaeogeographic evolution of these two cratons for the concerning period. There are some tectonic and lithostratigraphy differences prior to 2.02 Ga that support the hypothesis of two distinct blocks.

(1) The age of the sedimentary rocks of Armina in French Guiana is older (up to 2.132 Ga; Delor *et al.* 2001) than the age proposed for the Comoé basin (2.12–2.10 Ga, Vidal *et al.* 1996).

(2) After closure of the Atlantic and alignment of the Guri and Sassandra faults (Gibbs & Writh 1985) (Fig. 13), the NNE–SSW Palaeoproterozoic shortening event D_2 dated at 2.10–2.08 Ga (Vanderhaeghe *et al.* 1998) in French Guiana is incompatible in direction with the second shortening event D_2 recognized in the Ivory Coast (NE–SW, 2.10–2.07 Ga; Vidal *et al.* 1996). This NW–SE shortening event is know in the western part of the Guiana Shield (Fig. 13) and corresponds to the age of formation of the granulitic complex of Kanuku (2.26 ± 0.2 Ga, U/Pb age, Bosma *et al.* 1983). This age is close to the assembly age based on the two proposed APWPs.

6 CONCLUSION

Mineralogical investigations (magnetic experiments and petrography) show that euhedral to subhedral Ti poor magnetite in Palaeoproterozoic rocks of French Guiana and both magnetite and haematite in rocks of the Ivory Coast are the principal magnetic remanent carriers. The haematites observed in the trondjhemite, tonalite and granodiorite (TTGs, 2.20–2.15 Ga) from the Ivory Coast were formed as a partial transformation of magnetite, probably during the Birimian tectonothermal event (2.10–2.07 Ga). More than 20 per cent of the Palaeoproterozoic granitic rocks in French Guiana and the Ivory Coast show a lack or a low quantity of magnetic mineral. Contact tests carried out on Jurassic dykes and Palaeoproterozoic country rocks show that the local thermal influence were avoided at least 2 m from the dyke border.

The palaeomagnetic investigations isolated four distinguishable high-temperature magnetic remanent components. These high-temperature magnetic remanent directions are distinct from the

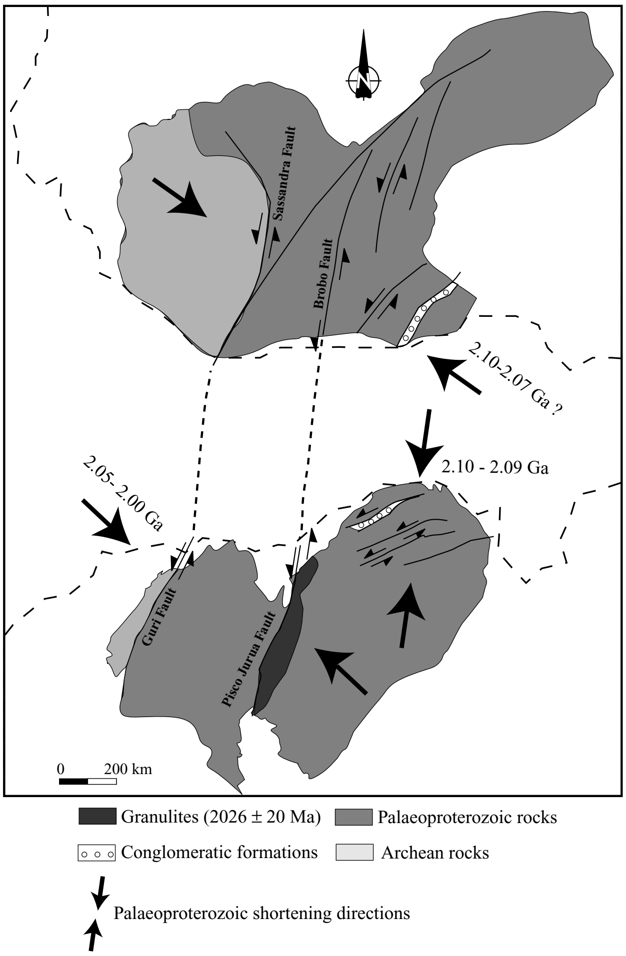

Figure 13. Reposition of Guiana with respect to the West Africa after closing the Atlantic Ocean and alignment of the Guri and Sassandra fault (Onstott & Hargraves 1981). West Africa is in its present position. The arrows show the Palaeoproterozoic regional shortening event and their propose age (Vidal *et al.* 1996; Vanderhaeghe *et al.* 1998).

present Earth's field and the local Jurassic palaeomagnetic components. Indeterminate reversal tests were obtained from the two French Guiana magnetic direction groups. These observations and mineralogical investigations suggest that the magnetic remanence represents a Palaeoproterozoic magnetization. Four new Palaeoproterozoic poles are calculated (GUI1, GUI2 from French Guiana; IC1, IC2 from the Ivory Coast): GUI1: $\lambda_{\mathrm{GUI1}} = -62^\circ$N, $\phi_{\mathrm{GUI1}} = 61^\circ$E, $k = 18$, $A_{95} = 10^\circ$, $N = 15$; GUI2: $\lambda_{\mathrm{GUI2}} = -5^\circ$N, $\phi_{\mathrm{GUI2}} = 50^\circ$E, $k = 26$, $A_{95} = 18^\circ$, $N = 5$; IC1: $\lambda_{\mathrm{IC1}} = -82^\circ$N, $\phi_{\mathrm{IC1}} = 292^\circ$N, $k = 28$, $A_{95} = 13^\circ$, $N = 6$; IC2: $\lambda_{\mathrm{IC2}} = -25^\circ$N, $\phi_{\mathrm{IC2}} = 83^\circ$E, $k = 11$, $A_{95} = 16^\circ$, $N = 9$. Using ^{40}Ar/^{39}Ar dating and other geochronological and lithstratigraphic correlation the age of the magnetic remanences are estimated for these French Guiana and the Ivory Coast poles to be:

(1) pole GUI1: 2.014 ± 0.027 Ga; pole GUI2: 1.993 ± 0.025 Ga;

(2) pole IC1: ∼2.085 ± 0.015 Ga; pole IC2: ∼ 2.000 Ga.

The combination of previously published palaeomagnetic and geochronologic data and our new poles, while limited, allow us to construct preliminary APWPs for the Guiana and West African Shields. The two paths seem to joint each other at about 2.02–1.99 Ga, and then follow the same trend. The older poles from these two shields are distinguishable in both pole positions and age. This suggests that these two cratons were assembled around 2.02 Ga to form a single block, which was separated with the recent opening of the Atlantic ocean.

This work demonstrates that the palaeomagnetic investigations of Palaeoproterozoic rocks can provide important information on palaeogeography and geodynamics. Nevertheless, more palaeomagnetic and geochronological studies have to be carried out on the Guiana and West African Shields to refine the APWPs.

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