Paleomagnetic Results from the Cretaceous Dumisseau Formation of Haiti

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ABSTRACT

Paleomagnetic studies of basalts and sediments from the Dumisseau Formation show that:

1) The basalt magnetizations are characterized by very low coercivity components. The sediments have generally higher but more variable stabilities against alternating field (AF) treatment compared to the basalts. The 200 oe AF mean directions for the Dumisseau basalt and sediment sites tend to fall near the present geomagnetic dipole field direction corresponding to the Latitude of Haiti. It is suggested that these rocks carry predominantly secondary magnetization of recent origin and there is little evidence for the preservation of remanent magnetization which may correspond to the time of formation of the rock units in the Late Cretaceous.

2) The remanent magnetic properties of the basalts, particularly those from the upper part of the formation in the Dumisseau area, are very similar to those reported for basalts recovered in the Caribbean DSDP Leg 15, Sites 146, 150, 151, 152 and 153, suggesting also similarities in their petrotectonic origin.

INTRODUCTION

The newly described Dumisseau Fm. (Maurrasse, et al., 1979a) crops out and forms the basement over an extensive area of the Southern Peninsula of Haiti. The unit, about 1.5km thick, consists of basaltic flows, pillows and sills, intercalated with sediment lenses which have baked contacts locally.
The proportion of sediment to basalt increases upsection, until the upper part of the formation consists almost entirely of calcareous sediment of deep sea facies. The formation exhibits complex structures in certain areas, with evidence of multiphase folding and faulting, but in the Dumisseau region, it is apparently less intensively deformed. The degree of weathering varies considerably, but fresh exposures are present along rapidly eroding ridge flanks, particularly in deeply incised river gorges. The Dumisseau Fm. has been interpreted as representative of a section of the Caribbean, oceanic, crust, below seismic reflector B". The age, based on microfossil evidence from the intercalated sediment, may be as old as Turonian, to as young as Campanian (Maurrasse, et al., 1979a).

Paleomagnetic samples used in the present work were collected in the field with a portable drill and oriented by Brunton compass. A total of 77 independently oriented samples distributed over 17 sites were obtained for study: 11 sites (59 samples) in basalt and 7 sites (18 samples) in sedimentary lenses. The site localities are shown in Figure 73. Most of the sample collection was from exposures in the vicinity of the Dumisseau Catholic Mission (Fig. 73). However, seven of the sites were occupied along the stream bed of the Grande Riviere in the coteaux area, about 500m lower in elevation than Dumisseau and presumably lower structurally in the section.

NRM and k

The distribution of natural remanent magnetization (NRM) intensities and the initial susceptibilities of the samples are shown in Figure 74.The basalts are strongly magnetized, and

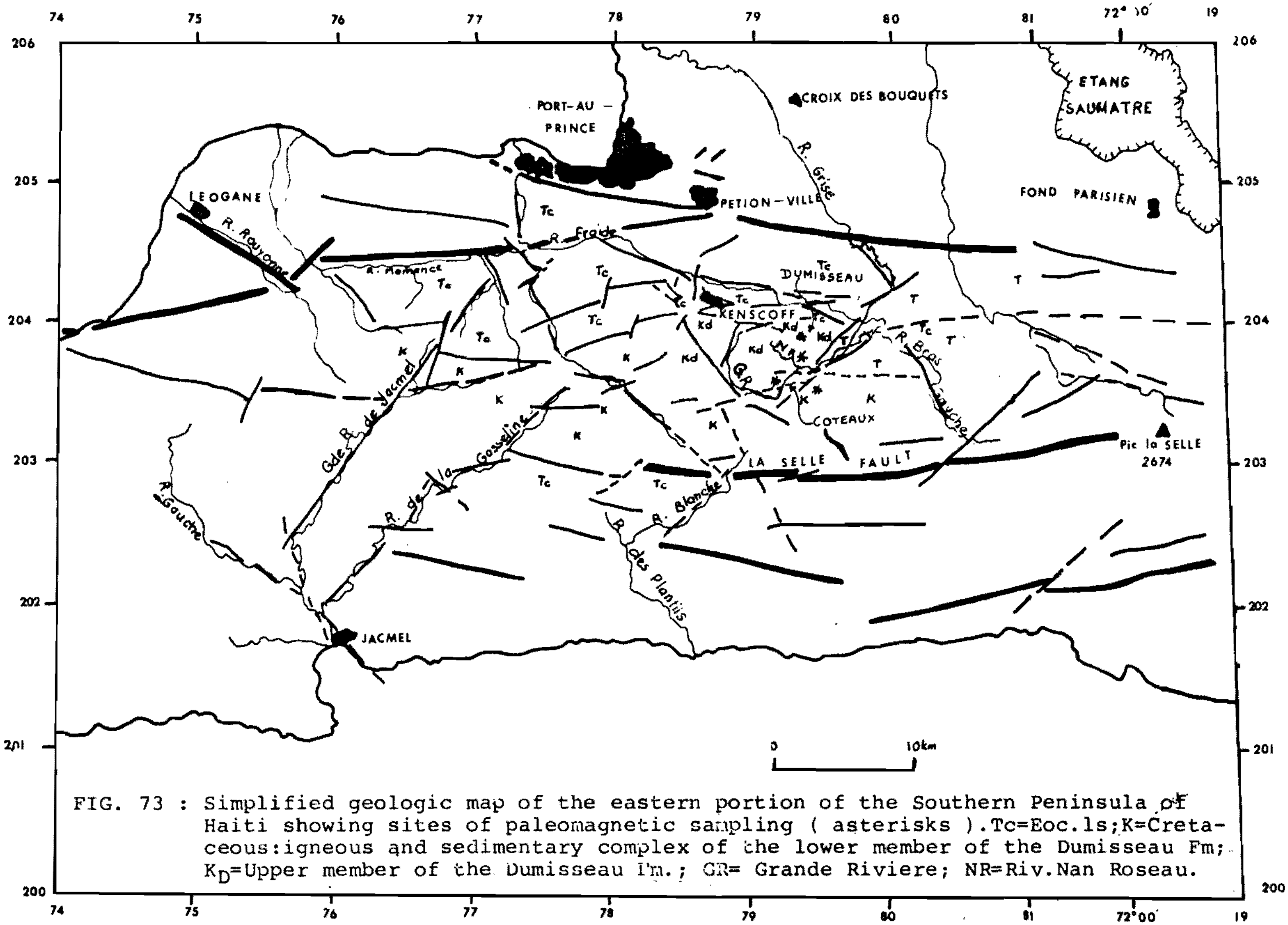
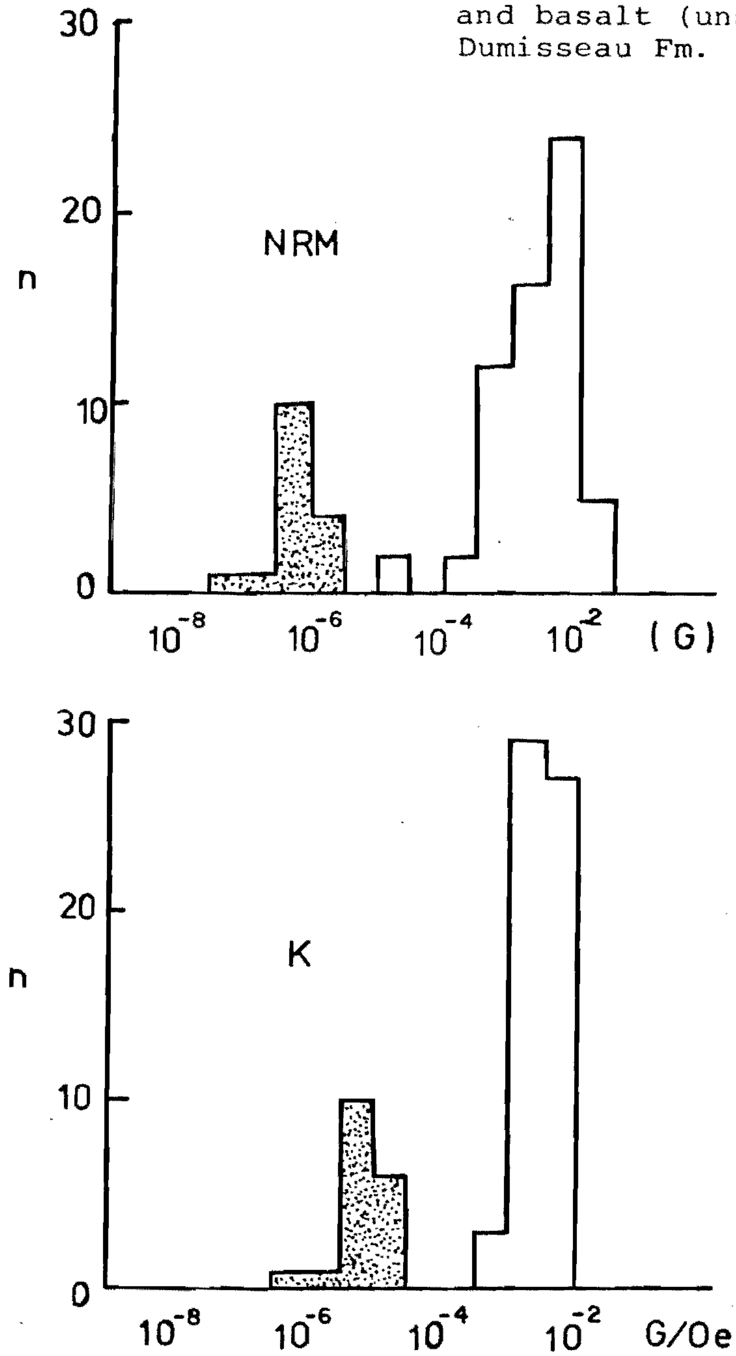


FIG. 73 : Simplified geologic map of the eastern portion of the Southern Peninsula of Haiti showing sites of paleomagnetic sampling (asterisks).Tc=Eoc.ls;K=Cretaceous:igneous and sedimentary complex of the lower member of the Dumisseau Fm; K_D=Upper member of the Dumisseau Fm.; GR= Grande Riviere; NR=Riv.Nan Roseau.

have a (geometric) mean NRM intensity of 4.4×10^{-3} Gauss. Their susceptibilities (k) have a (geometric) mean of about 3.5×10^{-3} Gauss/Oersted. The Konigsberger ratios (nrm/kH), where H is the present geomagnetic field intensity, are therefore typically greater than unity. These values compare favorably with averages of DSDPand dredge haul oceanic basalt collections as summarized by Lowrie (1977), and particularly with DSDP basalts recovered from the Caribbean on Leg 15 (Lowrie and Opdyke, 1973).

FIG. 74 : Frequency distribution of NRM intensities and susceptibilities of sediment (shaded) and basalt (unshaded) samples from the Dumisseau Fm.



The NRM intensities and susceptibilities of the sediments are markedly lower than the basalts (fig. 74) , with (geometric) means of about 3 X 10^{-6} G and 1 X 10^{-5} Gauss/Oersted, respectively. Several of the sediment lenses appeared to have baked contacts with the basalts, but little evidence of this is apparent in the magnetic properties. The low NRM intensities and Konigsberger ratios less than 1 are more typical of pelagic sediments rather than of rocks heated to produce a thermoremanent magnetization. It is possible that magnetochemical alteration has affected the baked sediments and reduced their magnetization.

STABILITY OF MAGNETIZATION

Pilot samples from each site were subjected to progressive alternating field (AF) demagnetization to investigate the stability of magnetization. Typical magnetization decay curves are shown in Figure 75. The basalt magnetizations are characterized by very low coercivity components. In all but two of the basalt sites, a 50 oe AF treatment is sufficient to remove more than half the initial NRM value. Likewise, less than 10% of the original magnetization typically remains after 200 oe AF. Samples from only two basalt sites (N,T) show more gradual reduction in NRM intensity with AF treatment, reflecting more stable remanences.

The sediments have generally higher, and more variable stabilities against AF treatment compared to the basalts. More than half of the original magnetization remains after 100 oe AF although some of the decay curves (fig. 75) tend to have an erratic pattern. This may be due, in part, to higher instrument noise levels in conjunction with the low NRM intensities of these samples.

The corresponding changes in sample magnetization direction with progressive AF demagnetization are shown on orthogonal projections of vector endpoints in figures 76 and 77. The majority of samples tested have a relatively simple, single component magnetization with moderate inclination, and northerly declination. The demagnetization trajectories typically decay uniformly to the origin over a relatively small range of AF demagnetization levels (Fig. 76a) although the trajectories are not as well-defined in some of the sediment samples (Fig. 76c). Progressive thermal demagnetization experiments on several samples of basalt support the AF demagnetization results. The same, single component of magnetization is revealed but over a wide range of demagnetizing temperatures, from 100°C to 580°C when the sample magnetization essentially disappears (Fig. 76b). The blocking temperatures are consistent with magnetite as the carrier of the remanent magnetization.

Exceptions to this pattern are some of the sites from the Coteaux area in which samples have either a single component with rather steep inclination (Fig. 77a) or have two components, an initial one usually with steep inclination followed by magnetization with a shallow direction that is revealed at higher levels of AF demagnetization (Fig. 77b).

DISCUSSION OF RESULTS

Calculated site mean paleomagnetic directions, after partial AF demagnetization of all samples at 100 oe and at 200 oe, are shown in Table 5 and in Figure 78. The 100 oe AF mean directions for the Dumisseau area basalt and sediment sites (Figure 78 a) tend to fall near the present geomagnetic dipole field direction corresponding to the latitude of Haiti. The grouping of site means is further improved after 200 oe AF (Figure 78 b), thus the nine sites from the Dumisseau area give an overall average direction of Decl = 358°, Incl = 32°, alpha 95 = 10° (Table 5), which is virtually identical to the present dipole field direction.

The Coteaux area site means do not fall near the present field direction; they are potentially more interesting because a more ancient or complex origin for the magnetization is therefore suggested. The sample directions are often well-grouped within each site and do not change appreciably between the 100 oe and 200 oe AF demagnetizations levels. Nevertheless there is

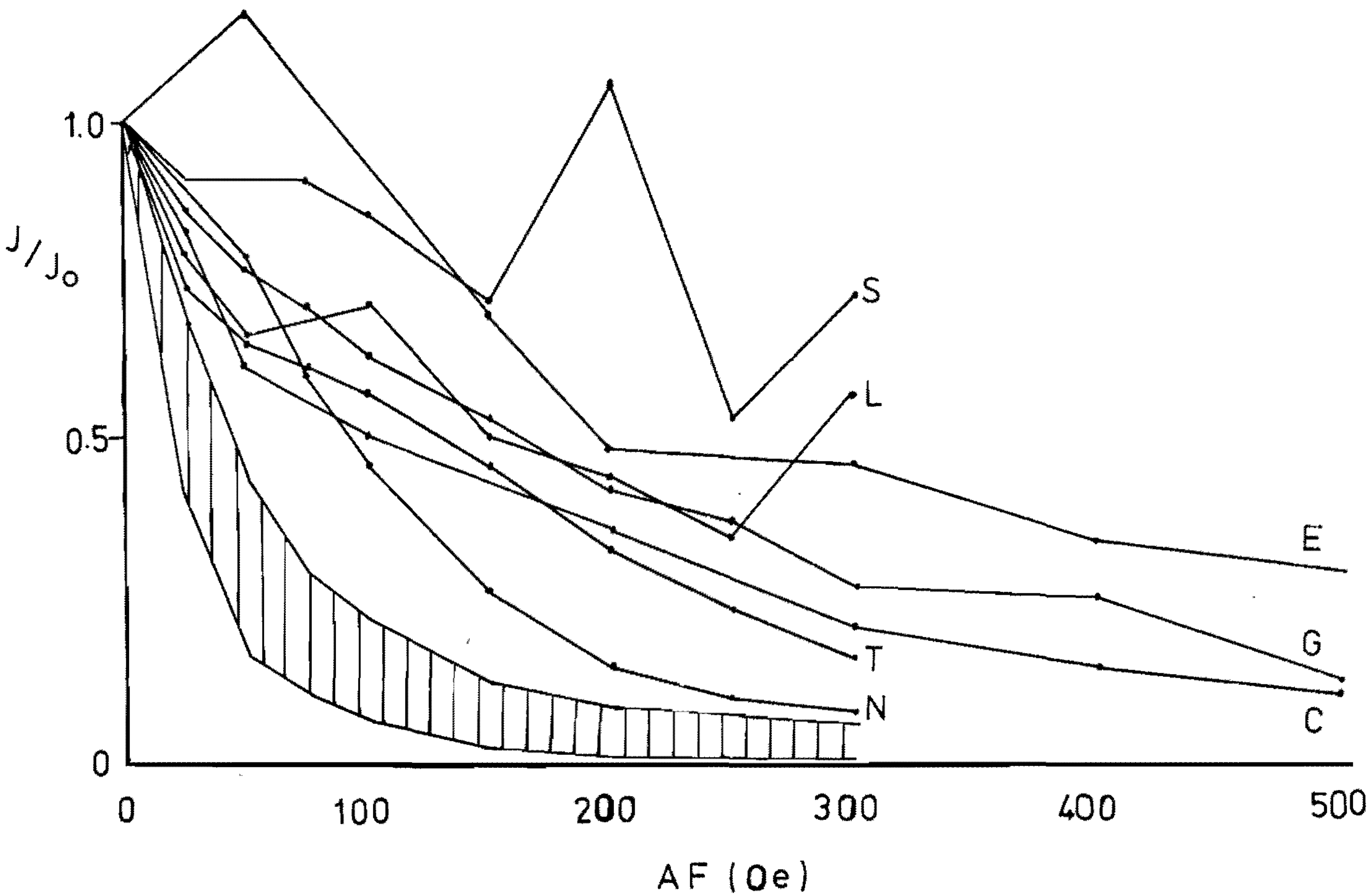


FIG. 75 : AF demagnetization decay curves of representative of sampling sites in the Dumisseau Fm. Vertically ruled region encompasses decay curves from sites D,H,I,J,K, M,O,PA, and R.

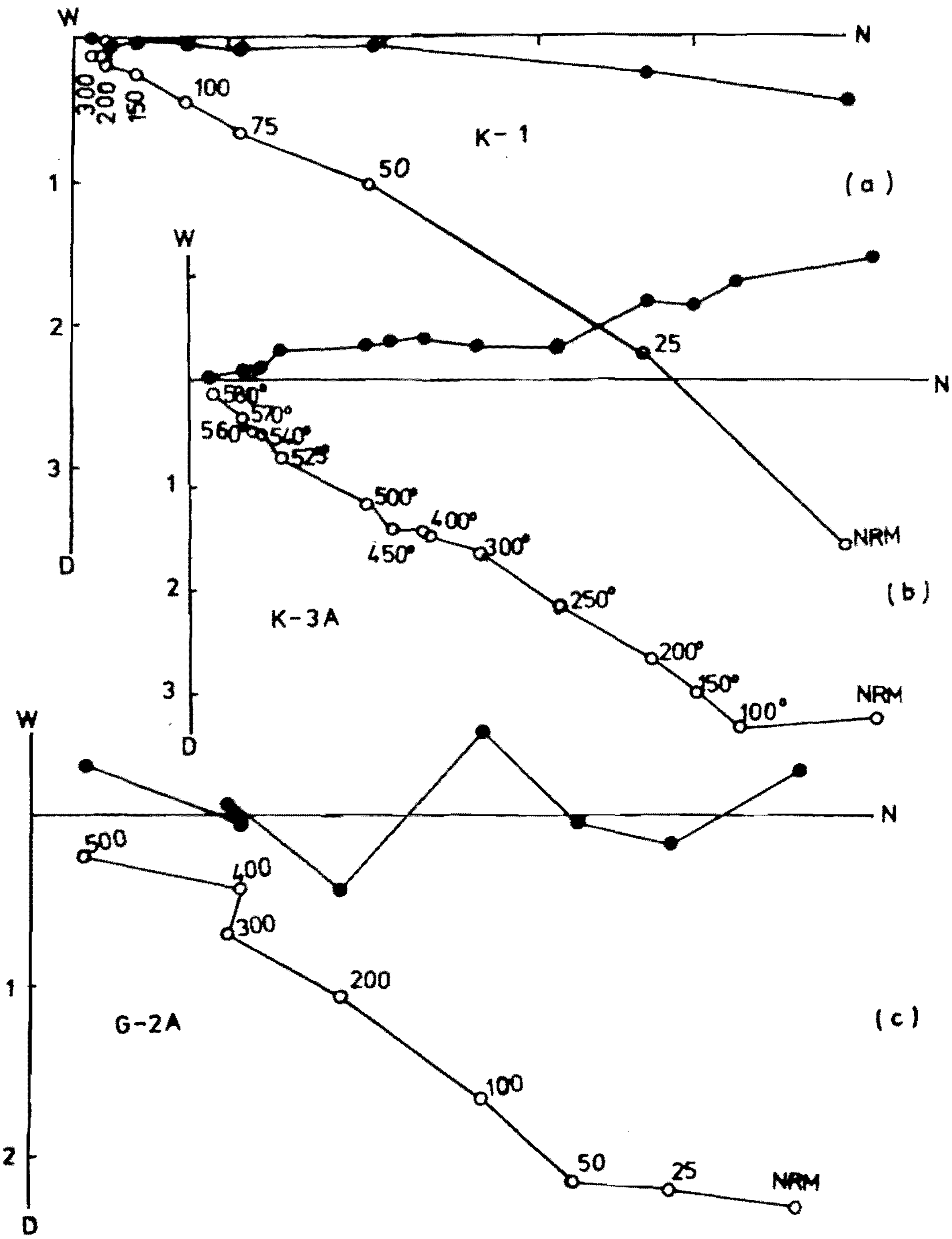


FIG. 76 : Orthogonal projections of vector-end points (Zijderveld,1967) for representative samples from the upper part of the Dumisseau Fm. Open (filled) symbols represent projections on the vertical (horizontal) plane. Numbers next to open symbols are AF demagnetizing fields in Oe, or thermal demagnetizing temperatures in ^{o}C. Upper and middle diagrams are for basalt samples from site K (axes units in $10^{-4}G$); lower diagram for sediment sample from site G (axes units in 10^{-3}Gauss).

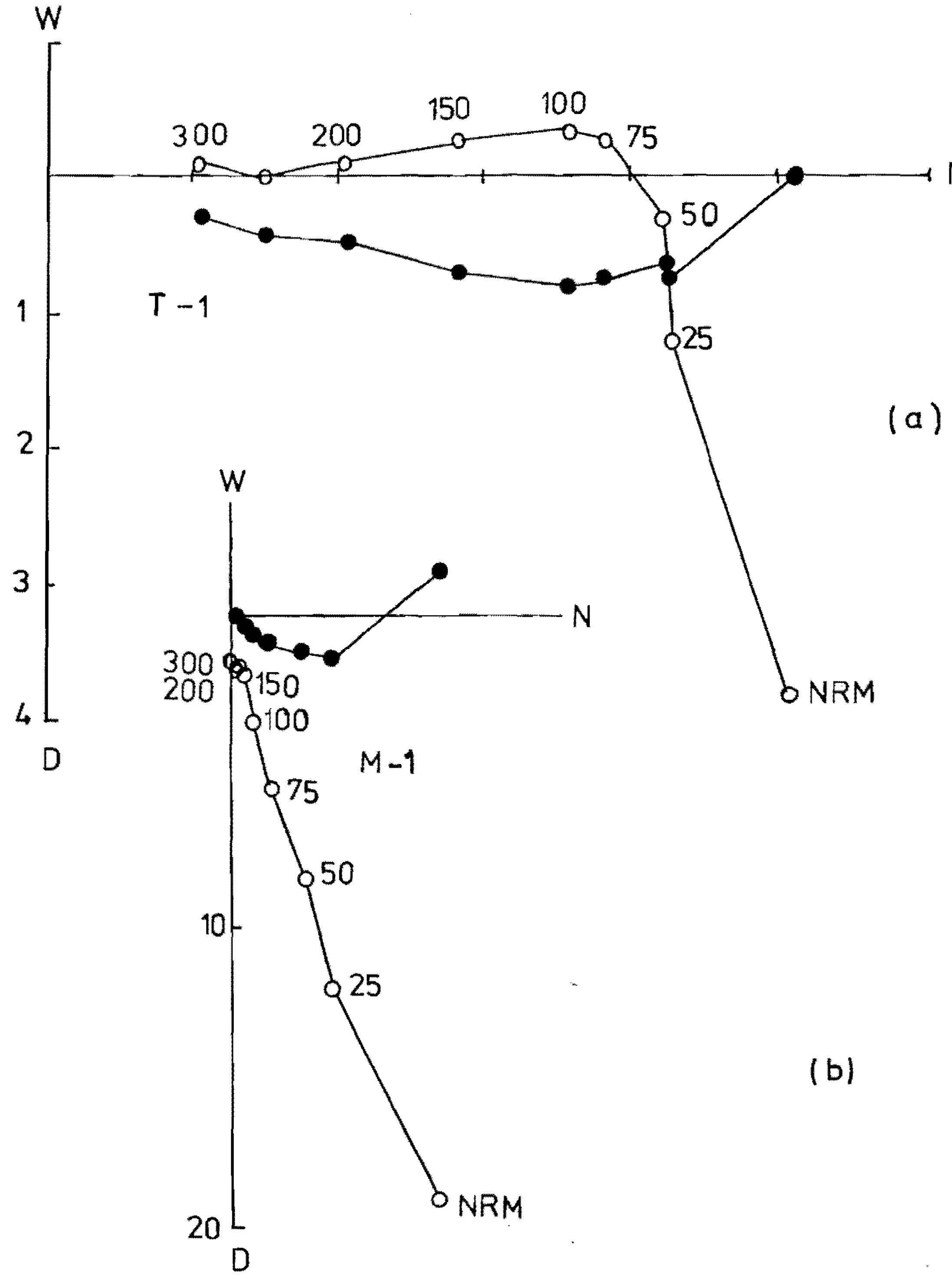


FIG. 7.7 : Vector end-point diagram for basalt samples from two sites in the lower part of the Dumisseau Fm. Explanation of symbols as in Fig.7.6. Axes units in 10^{-4}G.

large between-site scatter. Most of the site means have steep directions, between 50° and 70° inclination and wide variation in declination. Two sites give very shallow, northerly directions but steep inclination components were noted in individual sample demagnetization data. Correction for local bedding tilt at each site does not significantly improve the grouping and there is still large between-site scatter (Fig. 78c). The significance of these directions remains in doubt. A complex history of magnetization acquisition is further suggested by lack of agreement between closely spaced sites, for example, between PA and PB, and among sites R, S and T (Table 5), which were taken only a few meters apart.

TABLE 5. Summary of paleomagnetic results from the Dumisseau Formation

			100 oe					200 oe				
			Before T.C.		After T.C.		α_{95}(°)	Before T.C.		After T.C.		α_{95}(°)
Site	N	Rock type	D(°)	I(°)	D(°)	I(°)		D(°)	I(°)	D(°)	I(°)	
C	4	sediment	359	50	12	35	19	359	44	10	30	18
D	6	basalt	341.	34.	351.	25.	8	344	41	356	31	10
E	1	sediment	14	30	14.	-32.	-	18	24	22	-33	-
F	4	sediment	10	23	10	-10.	24	----------too weak----------				
G	3	sediment	335	11	346	-16.	51.	2	17	358	-3	36
H	5	basalt	16	24	6.	10.	18	5	21	359	2	21
I	5	basalt	333	20	332	-10	32	347	26	342	-1	19
J	3	basalt	355	37	352	21	13	353	36	350	20	14
K	5	basalt	5	49	358	34	9	10	51	2	36	13
L	3	sediment	352	31	350	14	63	346	27	345	10	62
M	5	basalt	51	55	359	51	18	53	56	358	53	19
N	5	basalt	231	68	272	41	7	233	66	271	39	6
O	5	basalt	2	64	329	36	8	2	64	329	36	8
PA	3	basalt	292	48	283	-9	13	304	48	290	-5	11
PB	2	sediment	35	57	302	46	-	48	46	315	57	-
R	6	basalt	347	72	294	54	17	9	69	304	60	28
S	3	sediment	4	3	1	9	16	356	-2	356	1	31
T	3	basalt	14	-2	13	9	15	14	-1	12	10	18

Mean of sites C, D, E, G, H, I, J, K, L (N=9, after 200 oe AF)

before T.C.: D=358° I=32°
alpha 95=10° k=28

after T.C.: D=358° I=11°
alpha 95=11° k=16

Notes: D,I. are the Declination, Inclination; T.C. is tilt correction of strata; alpha 95 and k are paleomagnetic statistical parameters (see McElhinny, 1973).

CONCLUSION

1) The NRM of the Dumisseau area basalts and intercalated sediments is on average aligned almost exactly along the geomagnetic dipole field even after partial AF demagnetization. On this basis, combined with the generally low magnetic stability of these rocks, the magnetizations are likely to be of recent origin. We find no strong evidence for the preservation of remanent magnetization which may correspond to the time of formation of the rock units in the Late Cretaceous although it is interesting that the tilt corrected mean direction (Table 5) for the Upper Dumisseau Fm. rocks is shallower and distinct from the present field.

2) The NRM of the basalts and sediments from the Coteaux area give poor between-site in directions but the site-mean directions generally fall away from the present geomagnetic field. Although recent acquisition of magnetization is not well supported in these rocks, the significance of the directions nevertheless remains puzzling, particularly the steep directions which do not correspond to any known Cretaceous or younger paleomagnetic field direction for North America (The Cretaceous pole for North America corresponds to a paleolatitude of about 11° or an excepted inclination of 22°, for Haiti). The lack of internal consistency of these paleomagnetic data as a whole does not permit any simple tectonic interpretation to be made but further work may eventually yield more understandable information.

3) The remanent magnetic property of the basalts, particularly those from the upper part of the formation in the Dumisseau area, are very similar to those reported for basalts recovered in the Caribbean by the Deep Sea Drilling Project at Sites 146, 150, 151, 152 and 153 (Lowrie and KENT, 1978). Of particular interest is the unstable nature of the magnetizations. Up to 93% of the NRM of the DSDP Caribbean basalt samples could be accounted for by a viscous remanence acquired in a 1.0 oe field over only 1000 hrs. The low coercivities of the Dumisseau Fm. basalts suggest that these too are likely to carry large viscous components, which would be consistent with the observation of paleomagnetic directions that are aligned along the present geomagnetic field at many of the sites. These unstable magnetic properties are not favorable for the preservation of the record of paleomagnetic field from the time of formation of these basalts which if they characterize the Caribbean crust, may help explain the generally poor development of correlatable sea-floor spreading marine magnetic anomalies in this region. The similarity of magnetic characteristics of the Dumisseau Formation basalts with DSDP basalts from the Caribbean is consistent with the interpretation that the Dumisseau Fm. is an uplifted portion of the Caribbean oceanic crust.

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