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GIOVANNI MUTTONI*

PRELIMINARY RESULTS ON THE PALEOMAGNETISM OF UPPER PERMIAN VERRUCANO LOMBARDO SANDSTONES FROM VAL CAMONICA AND OF UPPER TRIASSIC VAL SABBIA SANDSTONES FROM VAL BREMBANA (Southern Alps)

RIASSUNTO - *Risultati preliminari sul paleomagnetismo delle arenarie del Permiano Superiore del Verrucano Lombardo e delle Arenarie di Val Sabbia del Triassico Superiore della Val Brembana (Alpi Meridionali).*Questo articolo riguarda alcuni risultati preliminari sul paleomagnetismo delle arenarie del Permiano Superiore del Verrucano Lombardo (due siti, 29 campioni, Val Camonica) e delle Arenarie di Val Sabbia di età Carnico inferiore-medio (tre siti, 34 campioni, Val Brembana). L'autore è consapevole che il limitato numero di siti/campioni non permette di trarre alcuna conclusione definitiva. Ciononostante, è interessante osservare che il Polo Magnetico Virtuale (VGP) calcolato dalla componente caratteristica isolata nelle arenarie del Verrucano Lombardo (Lat.=46.2, Long.=237.0, A63=14.3, K=56, N=2) è in stretto accordo con i dati relativi al Permiano Superiore delle Alpi Meridionali e cade sulla porzione Permiana della Curva di Migrazione Apparente dei Poli (APWP) dell'«Africa» e dell'Europa ruotata in coordinate Africane. D'altro canto, il VGP ottenuto dalla componente caratteristica isolata nelle Arenarie di Val Sabbia (Lat.=S6.6, Long.=203.0, A63=8.1, K=44, N=3) cade ad Ovest della porzione triassica superiore dell'APWP dell'«Africa» e dell'Europa. Viene infine proposto e discusso un APWP per le Alpi Meridionali per l'intervallo di tempo compreso tra lo Stefaniano (Carbonifero Superiore) e l'Anisico superiore (Triassico Medio).

SUMMARY - This paper reports preliminary results on the paleomagnetism of the Upper Permian Verrucano Lombardo sandstones (two sites, 29 specimens, Val Camonica) and of the Lower-Middle Carnian (Upper Triassic) Val Sabbia Sandstones (three sites, 34 specimens, Val Brembana). The author is aware that the limited number of sites/specimens and the lack of field tests able to constrain the age of acquisition of the magnetic remanence do not lead to any exhaustive conclusion. Nevertheless, it is interesting to observe that the Virtual Geomagnetic Pole (VGP) calculated from the Verrucano Lombardo Ss. characteristic component (Lat.=46.2, Long.=237.0, A63=14.3, K=S6, N=2) is in full agreement with the Upper Permian data from the Southern Alps, and lies on the Permian portion of both the «African» and the rotated European Apparent Polar Wander Paths (APWPs). On the other hand, the Val Sabbia Ss. VGP (Lat.=56.6, Long.=203.0, A63=8.1, K=44, N=3) lies W of the Upper Triassic portion of the «African» and European APWPs.

According to literature data, a tentative Southern Alps APWP for the Stephanian (Late Carboniferous) to Late Anisian (Middle Triassic) time interval is proposed and discussed.

INTRODUCTION

It has been known for a long time that the Southern Alps are suitable for paleomagnetic analysis (see compilations by VAN DER VOO, 1993 and HELLER *et al.*, 1989). Investigations on Upper Paleozoic to Tertiary rocks started in the early 60's. In particular, in the Up-

* Dipartimento di Scienze della Terra dell'Università di Milano.

per Paleozoic to Lower Mesozoic stratigraphic succession, much effort has been devoted to the Permian volcanics and red beds and to the Triassic volcanics of Lombardy, the Vicentinian Alps and the Dolomites. On the other hand, the Permo-Triassic sedimentary sequence of the western Southern Alps (mainly Lombardy) has never been the object of major paleomagnetic research. Recently, a characteristic component positive at the fold test (at the 99% level of confidence) has been isolated in the Middle Triassic Prezzo Limestone at four sites in the western Southern Alps (Val Brembana and Giudicarie Alps) (MUTTONI & KENT, 1994; BALINI & MUTTONI, unpub. data). The mean pole calculated from this characteristic component (Lat.=61.9, Long.=230.6, A9S=5.8, A63=2.7, K=252, N=4) lies close to the Triassic portion of the West Gondwana (in NW African coordinates) Apparent Polar Wander Path (APWP), according to the recent review by VAN DER VOO (1993, tab. 5.8). Such an evidence implies that this pre-folding characteristic component is a good candidate to represent the Middle Triassic geomagnetic field[1].

Because of the possible presence of a primary component in the Triassic sediments of the western Southern Alps, further sampling has also been performed in the Upper Triassic Val Sabbia Sandstones (VS Ss.) and in the Upper Permian Verrucano Lombardo sandstones (VL Ss.), with the aim to test the suitability of these rocks for paleomagnetic analysis. This paper reports some preliminary results on the paleomagnetism of the VS Ss. (three sites, 34 specimens, San Giovanni Bianco and Camerata Cornello village area, fig. lA, B) and of the VL Ss. (two sites, 29 specimens, Darfo and Eslne village area, fig. lA, C).

BASIC LITHOLOGICAL DESCRIPTION

The Verrucano Lombardo Ss. and the Val Sabbia Ss. represent two relevant terrigenous events in the Permian to Triassic sedimentary sequence of the western Southern Alps.

Verrucano Lombardo Sandstones

According to the data of FONTANA & ZUFFA (1982) and following the classification of FOLK (1974), in the Val Camonica area VL Ss. consist of volcanic arenites, feldspathic litharenites and subordinately lithic arkose (composition ranging from $Q_{63}F_{11}L_{26}$ to $Q_{39}F_{15}L_{46}$; QFL detrital modes after DICKINSON, 1970) (SCIUNNACH, pers. comm., 1993). Because of the lack of fossil content, VL Ss. are difficult to date. However, a Late Permian age (Tatarian to Dorashamian) for the VL Ss. deposited above the Artinskian-Ufimian Collio and Tregiovo basins has been suggested by CASSINIS *et al.* (1993). The VL Ss. are generally considered the product of fluvial deposition, from coarse alluvial fans (Luganese) to proximal braided rivers (Comasc Alps) and distal braided rivers (Bergamasc Alps). The vertical evolution of the VL redbeds is characterized by an overall fining-upward trend, from alluvial fan conglomerates to braided stream deposits (CASSINIS *et al.*, 1988). The presence of pedogenetic calcrete and gypsum along with other sedimentological characteristics suggest semi-arid conditions (CASSINIS *et al.*, 1988).

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[1] It has to be emphasized that the paleomagnetic directions isolated in the Prezzo Limestone show the best grouping at somewhat less than full tilt correction, which may suggest a syn-folding remagnetization. However, this possibility is not well supported because, as MUTTONI & KENT (1994) report, «...the increase by a factor of only 1.9 in the precision parameter at this intermediate (88%) step of tilt correction compared to that at full (100%) tilt correction is not statistically significant»

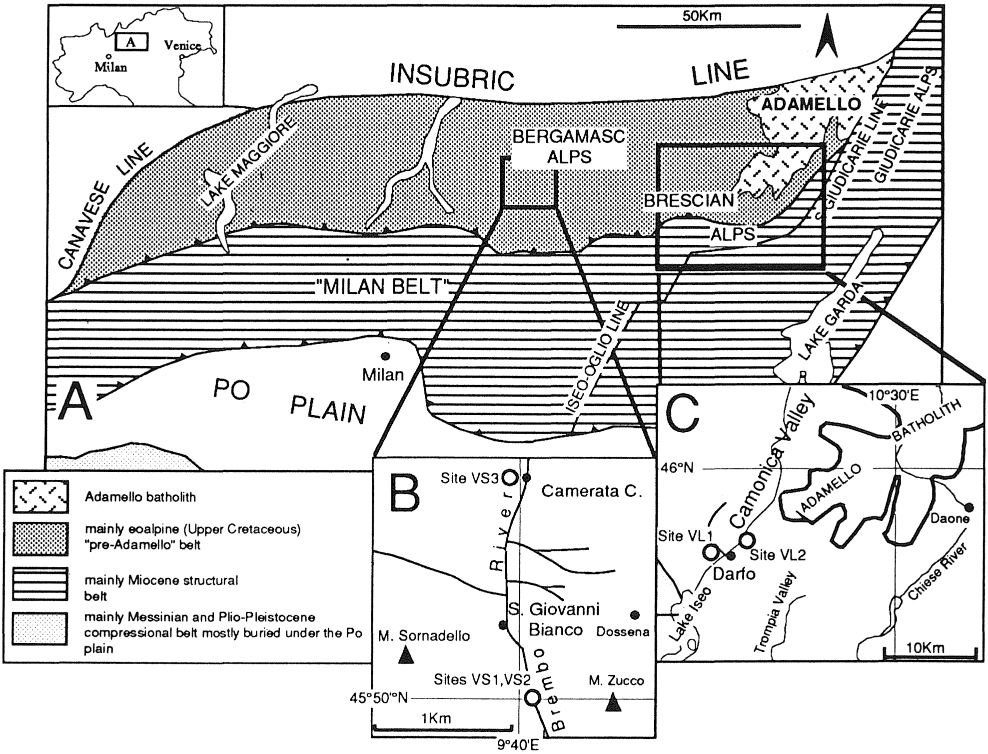

Fig. 1 - (A) Simplified geologic map of the Southern Alps (slightly modified from CASTELLARIN *et al.*, 1992). (B) Geographic map of the central Val Brembana (Lombardy). Sites VS1 and VS2 have been sampled on the riverside between San Pellegrino and San Giovanni Bianco, whereas site VS3 is located near Camerata Cornello. (C) Geographic map of the central Val Camonica (Lombardy). Site VLl is located on the road from Darfo to Capolago, near Moro lake; site VL2 is from the Esine village area.

Val Sabbia Sandstones

The Val Sabbia Sandstones are Early-Middle Carnian (Late Triassic) in age and consist of greenish-grey to red fine to medium-grained siltstones and sandstones. In Val Brembana (S. Gallo borehole, GARZANTI & JADOUl, 1985) VS Ss. are subdivided into three stratigraphically superposed members: a lower green (132 m-thick), an intermediate red (about 338 m-thick) and an upper green member (about 50 m-thick). Red and green pigmentations are due to the early diagenetic formation of, respectively, hematite and clorite (GARZANTI & JADOUL, 1985). Paleomagnetic samples have been collected in the intermediate hematite-bearing red member. Petrographically VS Ss. mainly consist of plagioclase-bearing volcanic arenites (classification after FOLK, 1974), and show a fairly homogeneous composition ranging from $Q_5F_{41}L_{54}$ to $Q_7F_{42}L_{51}$ (GARZANTI & JADOUL, 1985). According to GARZANTI & JADOUL (1985), the Carnian sediments of Val Brembana are arranged in a regressive megasequence testifing the transition from lagoonal facies (basal Gorno Fm.) to a lower and subaerial delta plain paleoenvironment, prograding as a consequence of a great supply of terrigenous detritus from a southern volcanic belt. In particular, the VS Ss. intermediate red member outcropping along the Brembo river-banks has been attributed to a subaerial delta plain getting more and more proximal.

PALEOMAGNETIC TECHNIQUES

All the specimens were taken with a portable water-cooled drill and oriented by means of a magnetic compass. Successively, in the laboratory they were subjected to complete stepwise thermal demagnetization. Remanence measurements were performed in a 2G 3-axis cryogenic magnetometer located in a magnetically shielded room. For some of the specimens mineral alterations after each heating step were monitored with a Bartington Susceptibility Meter MS2. Principal Component Analysis (KIRSCHVINK, 1980) was applied to

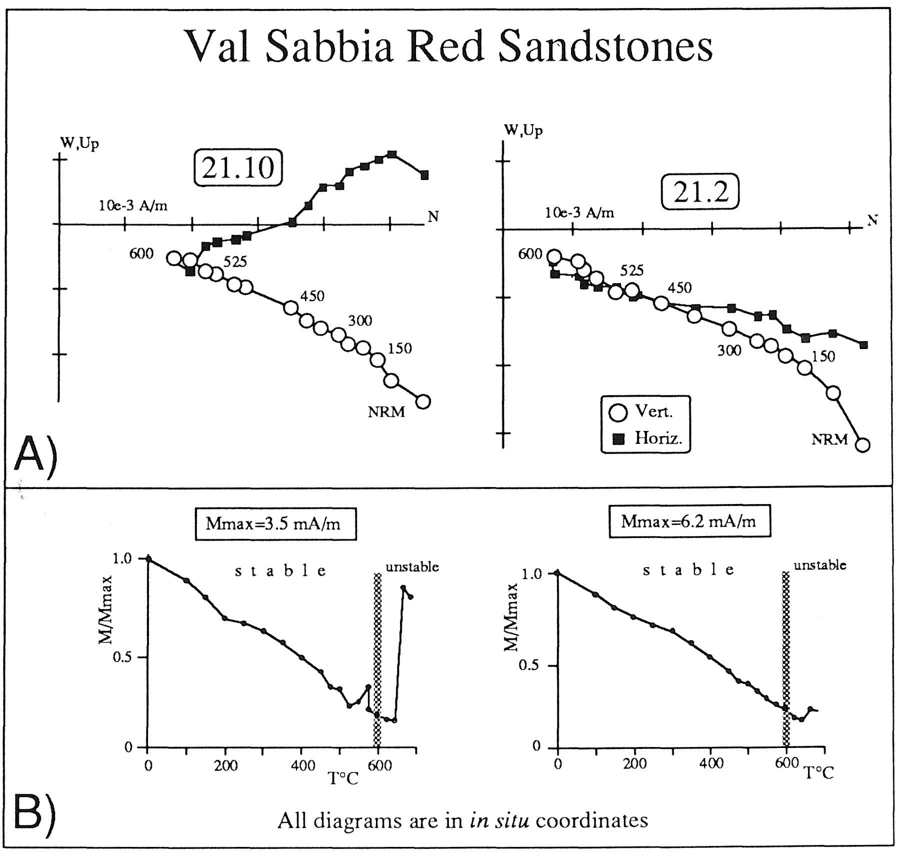

Fig. 2 - (A) Examples of orthogonal projections of thermal demagnetization data and (B) curves of thermal decay of Natural Remanent Magnetization (NRM) for two Val Sabbia Ss. samples. Solid squares are projections onto the horizontal plane, open circles onto the vertical plane. All diagrams are in *in situ* coordinates. See text for discussion.

determine the component directions, chosen by inspection of orthogonal projections of thermal demagnetization data (ZIJDERVELD, 1967). Mean directions were determined with standard Fisher statistics (FISHER, 1953).

PALEOMAGNETIC DIRECTIONS

VS Ss. sites VSI, VS2 and VS3 (red sandstones)

In situ orthogonal projections of thermal demagnetization data indicate the presence of two stable magnetization components: a soft component consistent with the present-day magnetic field is removed between 100-200 and 350 °C, whereas a characteristic component oriented N-and-down is successively isolated from about 350-400 to 600-625 °C (fig. 2A).

The unblocking temperature spectra of NRM indicate a maximum unblocking temperature for the stable remanence of about 625-650 °C (fig. 2B). Above this temperature the NRM becames highly instable and viscous, probably because of mineral alteration during heating. When mineral alteration is developed at temperatures somewhat lower than 600°C, the characteristic component cannot be precisely isolated and the sample direction is rejected (10% of samples rejected at site VSl, 30% at site VS2 and 36% at site VS3).
Although the remanence cannot be completely resolved, the maximum unblocking temperature of the stable remanence and the red colour of the sediment confirm the presence of hematite as main magnetic carrier.

After correction for bedding tilt the characteristic component site-mean directions are oriented N/NW-and-down (fig. 3A, tab. I), and the overall mean direction is Dec.=352.3, Inc.=24.2 (fig. 3B, tab. I).

VL Ss. sites VLl and VL2 (red sandstones)

Two sites have been sampled in VL Ss. medium-grained red sandstones. *In situ* orthogonal projections of thermal demagnetization data (fig. 4A) indicate the presence of three progressively isolated components. After removal of a soft component carrying the present-day magnetic field, a "B" component is isolated between 200 and 500 °C. This component shows dual polarity at site VL2 (with 94% of normal directions) and is oriented NW-and-down (SE-and-up), whereas at site VLl it bears only reversed directions oriented SE-and-up. A characteristic component directed SE-and-up and bearing unblocking temperature spectra ranging from about 625 to 685 °C at site VL2 and 500 to 665-685 °C at site VLl is finally isolated.

The unblocking temperature spectra of NRM suggest the presence of hematite (fig. 4B). According to FONTANA & ZUFFA (1982), hematite was originated during the early diagenesis as consequence of Fe oxidization in subaerial conditions. No mineral alteration seems to take place during heating. At site VLl the 46% of the samples did not yield resolvable characteristic component directions.

After correction for tilting the VL Ss. "B" component directions are oriented NW-and-down (SE-and-up) at site VL2 and SE-and-up at site VLl (fig. 5, tab. I). At site VLl the "B" directions are highly scattered and do not show a fisherian distribution.

As regards the characteristic component, after correction for bedding tilt the VL Ss. site-mean directions are oriented SE-and-up at both sites (fig. 6A, tab. I). The overall mean is Dec.=148.9, Inc.=20.5 (fig. 6B, tab. I).

DISCUSSION

Two sites in the Verrucano Lombardo Ss. and three sites in the Val Sabbia Ss. provided a stable characteristic remanence. No field test is available to bracket the age of this remanence. The author is perfectly aware that the limited number of sites/specimens and the lack of age-constraining tests do not lead to any exhaustive conclusion. Nevertheless, some observations can be made.

Discussion on the VL Ss. and VS Ss. Virtual Geomagnetic Poles

The Southern Alps are thought to be autochthonous. All Paleozoic to Cenozoic paleomagnetic directions from the Southern Alps taken from literature data (see the compilation by VAN DER VOO, 1993) generally appear to be internally consistent and show an African

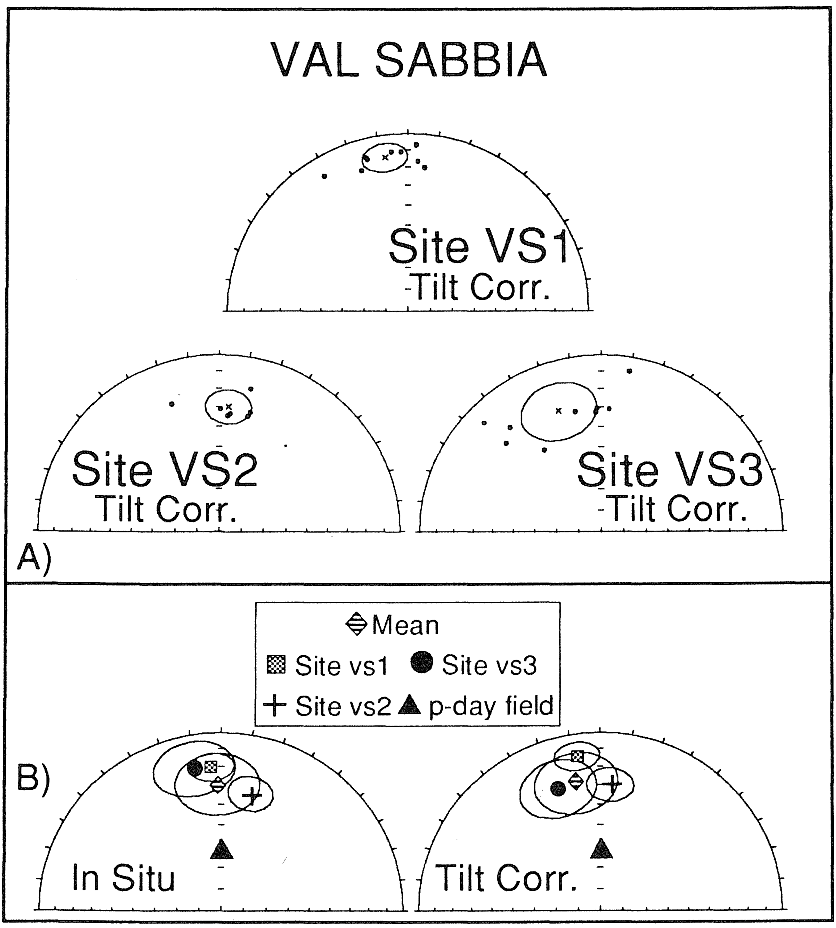

Fig. 3 - Stereographic projections of (A) the tilt corrected characteristic remanence detected in the Val Sabbia Ss. sites, provided with the a95 cone of confidence around the mean and of (B) the mean direction of the characteristic remanence of each site before and after correction for tilting.

affinity, being 45° to 50° counter-clockwisely rotated with respect to stable Europe for pre-Late Cretaceous times. This internal consistency led Van Den Berg & Zijderveld (1982) to construct a Permian to Tertiary APWP for the eastern Southern Alps which, at least for the south- and northward movements, is similar to the Africa one.

Figure 7A reports the Stephanian (Upper Carboniferous) to Upper Triassic poles of Table 2, characterized by a quality index Q≥3 (Q after Van Der Voo, 1989): pole i is Stephanian (296-263 Ma) [All ages according to the DNAG time scale, Palmer (1983)], poles 2 to 6 are Stephanian to Lower Permian (296-258 Ma), poles 7 to 13 are Upper Permian to Lower Triassic (258-240 Ma), *vl C.tc* is the Virtual Geomagnetic Pole (VGP) calculated from the tilt corrected site-mean characteristic directions of VL Ss. sites (Upper Permian) (tab. I). Stephanian to Lower Permian and Upper Permian poles are well grouped. Moreover, *vl C.tc* pole is in full agreement with the Upper Permian poles.

Poles 14 to 15 are Permian to Triassic, poles 16 to 20 are Triassic (245-208 Ma), *vs C.tc* is the VGP calculated from the tilt corrected site-mean characteristic directions of VS Ss. sites (Lower-Middle Carnian). Triassic poles show a more scattered distribution and generally lie north of the Permian ones. Pole 18 from Upper Anisian limestones from the western Southern Alps (Balini & Muttoni, unpub. data), and pole 20 from Norian (Upper Triassic) dolostones from the Vicentinian Alps (De Boer, 1963) are the only Triassic poles obtained from Southern Alps limestones. The anomalous position of pole 20 (with a quality index Q=2) raises the suspect either of remagnetization or of local tectonic rotation.

Tab. I - Statistical parameters of the paleomagnetic directions isolated in the Verrucano Lombardo Ss. and in the Val Sabbia Ss.

		Comp.	N(Nt)	Ds (°)	Is (°)	Dtc (°)	Itc (°)	ktc	(a95)tc (°)	Lat.s (°N)	Long.s (°E)	Lat.tc (°N)	Long.tc (°E)
Val Sabbia	**Site VS1**	ChR	9(10)	356.0	20.6	351.6	13.5	40	8.2			50.6	202.6
	Site VS2	ChR	7(10)	14.0	32.8	4.3	29.8	46	9.0			60.2	181.0
	Site VS3	ChR	9(14)	349.5	19.7	341.3	28.3	13	15.1			55.7	222.7
Verr. Lombardo	**Site VL1**	B	14(14)	135.3	-13.7	138.4	-7.3		non fisherian				
	Site VL2	B	17(17)	311.5	38.7	313.4	4.0	15	9.6	44.0	265.2	30.1	247.1
										dp/dm = 6.8/11.4		dp/dm = 4.8/9.6	
	Site VL1	ChR	8(14)	151.9	-36.1	160.0	-24.5	17	13.8			53.1	223.9
	Site VL2	ChR	17(17)	137.5	-50.9	138.4	-15.9	27	7.0			38.2	246.9
MEAN DIRECTION	Val Sabbia	ChR	3	359.3	24.7	352.3	24.2	35	21.1				
	V. Lomb	ChR	2	145.6	-43.7	148.9	-20.5	27	49.8				
												A95(A63) (°)	**K**
POLE POSITION	Val Sabbia	ChR	3							56.6	203.0	18.9(8.1)	44
	V. Lomb.	ChR	2							46.2	237.0	49.2(14.3)	56

Comp.: component designation; *N*: number of 10cc samples used for statistical analysis and number of sites for the mean directions and pole positions; *(Nt)* number of 10cc samples collected in the field. *Ds, Is and Dtc, Itc*: declination and inclination in *in situ* and tilt corrected coordinates, respectively. *ktc*: precision parameter after tilt correction. *(a95)tc*: half-angle of cone of 95% confidence about the mean direclion in tilt corrected coordinales. *Lat.s (°N)* and *Long.s (°E)*: latitude and longitude of Virtual Geomagnetic Pole in *in situ* coordinates. *Lat.tc (°N)* and *Long.tc (°E)*: latitude and longitude of Virtual Geomagnetic Pole in tilt corrected coordinates. *A95(A63)*: half-angle of cone of 95(63)% confidence about the pole. *K*: precision parameter of the pole.

Finally, the position of the Virtual Geomagnetic Poles calculated from the *in situ* and tilt corrected site-mean "B" directions of VL Ss. site VL2 (vl2 B.s and vl2 B.tc, respectively) are more difficult to interpret. As igure 7A shows, vl2 B.s lies far off all the plotted Permo-Triassic poles, whereas, after correction for tilting, pole v12 B.tc gets closer to the Stephanian to Lower Permian group of poles.

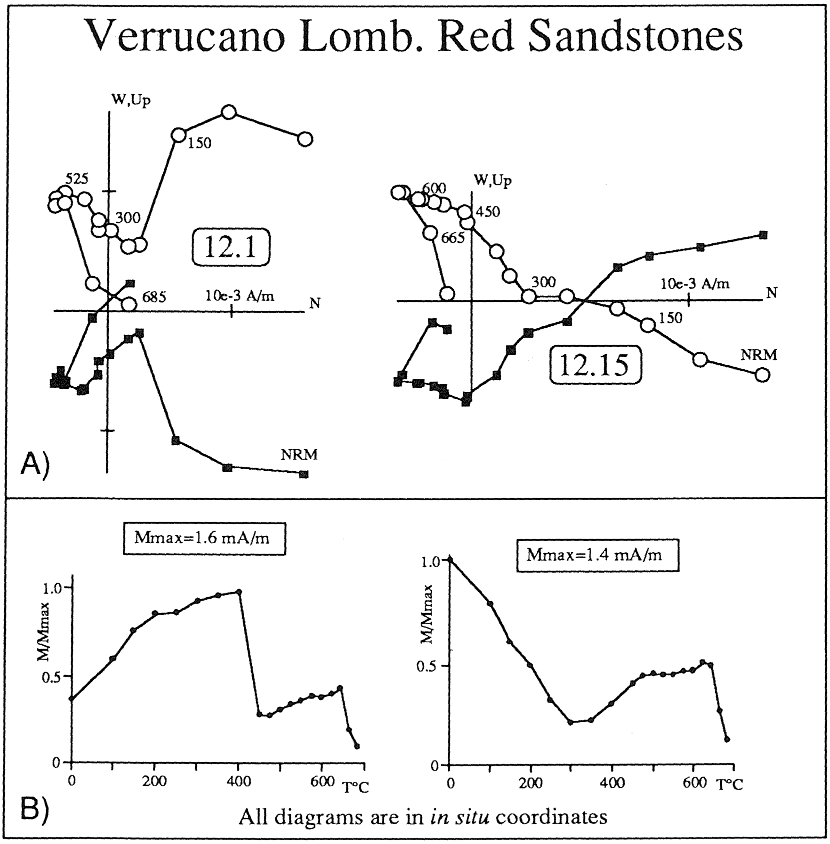

Fig. 4 - (A) Examples of orthogonal projections of thermal demagnetization data and (B) curves of thermal decay of Natural Remanent Magnetization (NRM) for two Verrucano Lombardo Ss. samples (site VL2). Solid squares are projections onto the horizontal plane, open circles onto the vertical plane. All diagrams are in *in situ* coordinates. See text for discussion.

A tentative Stephanian to Anisian APWP for the Southern Alps

Mean poles of Stephanian to Lower Permian (Lat. 39°N, Long. 245°E) and Upper Permian to Lower Triassic (Lat. 47°N, Long. 238°E) are reported in tab. II (bold lines) and plotted in Figure 7B. Among the more controversial Triassic poles, fig. 7B reports the recent and well dated Upper Anisian pole 18 (Lat. 62°N, Long. 231°E). The tentative APWP obtained from these poles (striped circles) is compared with (i) the APWP of West Gondwana in northwest African coordinates (VAN DER VOO, 1993) (solid diamonds), (ii)

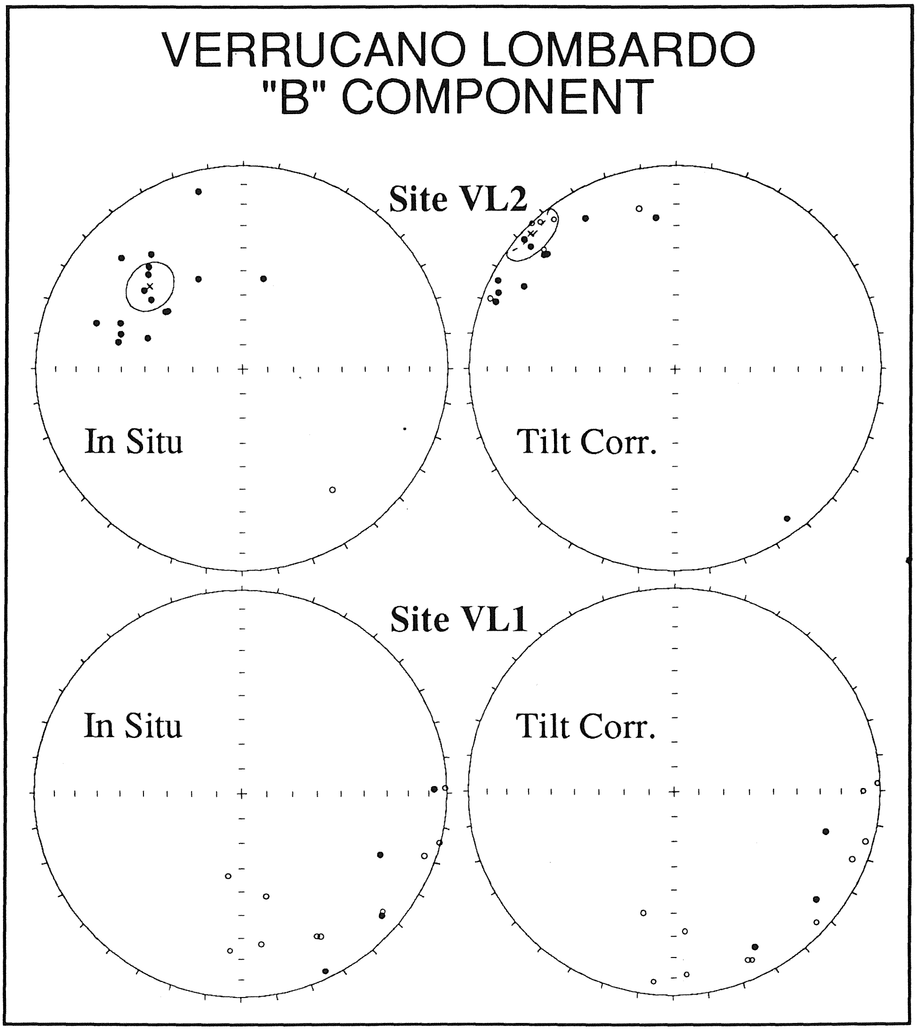

Fig. 5 - Stereographic projections of the *in situ* and tilt corrected "B" component directions detected in the Verrucano Lombardo Ss. sites VL2 and VLl, provided with the a95 cone of confidence around the mean.

the APWP of Gondwana in northwest African coordinates (VAN DER VOO, 1993) (solid squares) and (iii) the APWP of Europe (VAN DER VOO, 1993) (open circles), rotated to African coordinates by rotation parameters derived from KLITGORD & SCHOUTEN (1986) and SRIVASTAVA & TAPSCOTT (1986).

The Stephanian to Lower Permian and the Upper Permian to Lower Triassic mean poles from the Southern Alps basically fit the Lower and Upper Permian mean poles of «Africa»[2]) and Europe, with the exception of the West Gondwana Upper Permian pole, whore hi-

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[2] «Africa» is either West Gondwana or Gondwana supercontinent rotated to northwest African coordinates.

Tab. II - Permian to Triassic poles from the Southern Alps (modified from VAN DER VOO, 1993).

	n.	Rock Unit	Locality	Age	Lat. (°N), Long. (°E)	k	a95 (°)	a63 (°)	Plat. (°N)	Reference
Stephanian (Upper Carboniferous) / Lower Permian	1	Auernig Group	Carnic Alps	296-286	36, 243	8	18			Manzoni et al. (1989)
	2	Auccia volcanics	Lombardy	296-263	38, 245	89	8			Heiniger (1979)
	3	Arona volcanics	Lombardy	296-263	35, 248	47	14			Heiniger (1979)
	4	Lower Collio & Auccia volcanics	Lombardy	296-263	39, 252	15	20			Zijderveld & De Jong (1969)
	5	Lugano (Ganna) porphyries	Ticino	296-263	43, 243	76	10			Heiniger (1979)
	6	Bolzano quartz porphyries combined	Dolomites	286-263	45, 239		4			Zijderveld et al. (1970)
		MEAN (N=6)		**296-263**	**39, 245**	**288**	**4,3**	**2,2**	**8**	
Upper Permian / Lower Triassic	7	Val Gardena sandstones	Dolomites	258-245	42, 237	26	18			Manzoni (1970)
	8	Verrucano Lombardo metasediments	Lombardy	258-245	47, 237		6			Kipfler & Heller (1988)
	9	Val Gardena clastics	Vicentinian Alps	258-245	48, 238	117	7			De Boer (1963)
	10	Verrucano Lombardo red beds	Lombardy	258-245	48, 239		5			Kipfler & Heller (1988)
	11	Val Gardena sandstones	Dolomites	258-245	51, 235					Guicherit (1964)
	12	Staro & Camparmo acid flows	Vicentinian Alps	258-245	53, 241	220	6			De Boer (1963)
	vl.Ctc	Verrucano Lombardo sandstones	Camonica Valley	258-245	43, 241	dp/dm = 3,9/7,5				present work
	13	Werfen Formation	Dolomites	Scythian 245-240	42, 233	dp/dm = 3,4/6,8				Channel & Doglioni, in press
		MEAN (N=8)		**258-240**	**47, 238**	**317**	**3,1**	**1,6**	**12**	
Permo-Trias.	14	W. Ljubljana	Julian Alps	263-230	43, 235	9	19			Soffel et al. (1983)
	15	Bolzano area flows Group I	Dolomites	263-230	46, 217	9	7			Forster et al. (1975)
Triassic	16	Trl/m Vicentinian Alps combined	Vicentinian Alps	245-230	57, 249	218	4			De Boer (1963)
	17	Valle di Scalve porphyries	Lombardy	238-232	52, 221		6			Zijderveld & De Jong (1969)
	18	**Prezzo Limestone**	**W Southern Alps**	**U. Anisian ≈235**	**62, 231**	**252**	**5,8**	**2,7**	**23**	**Balini&Muttoni (unpub.)**
	19	Ladinian-Carnian volcanics	Dolomites	233-227	48, 240	22	9			Manzoni (1970)
	vs.Ctc	Val Sabbia Ss.	Brembana Valley	230-225	57, 203	44	19	8		present work
	20	Norian dolostones	Vicentinian Alps	225-208	69, 151					De Boer (1963)

n: number of reference for the poles plotted in Fig. 7A; k: precision parameter of the mean direction; a95(63): cone of 95(63)% confidence about the mean direction; Plat (°N) are paleolatitude values calculated for a generic point at Lat. 46°N, Long. 10°E. Bold rows report the statistics of the poles constituting the tentative APWP of Fig. 7B.

gh latitude is regarded with suspect (CHANNELL, pers. comm.). These data once again confirm the African affinity of the Southern Alps since the Permian. Moreover, during Permian times Pangea supercontinent moved northwards, as paleoclimatic evidences suggest (WITZKE, 1990). This latitudinal displacement is confirmed by all the plotted APWPs.

The Triassic scenario is much more controversial. The Lower to Upper Triassic mean poles of the «Africa» and Europe APWPs are extremely scattered. Upper Anisian (Middle Triassic) pole from Prezzo Limestone (pole 18) is in agreement with the upper Middle Triassic to Upper Triassic portion of the APWP of West Gondwana. Finally, the VGP calculated from the Val Sabbia Ss. tilt corrected characteristic component (*vs C.tc*) (fig. 7A), not included in the Southern Alps APWP discussed here because too poorly constrained as regards age and statistics, seems to lie W of the Upper Triassic portion of both the West Gondwanan and the rotated European APWPs (note that a similar conclusion can be also traced when considering the VS Ss. VGP calculated from the *in situ* characteristic directions).

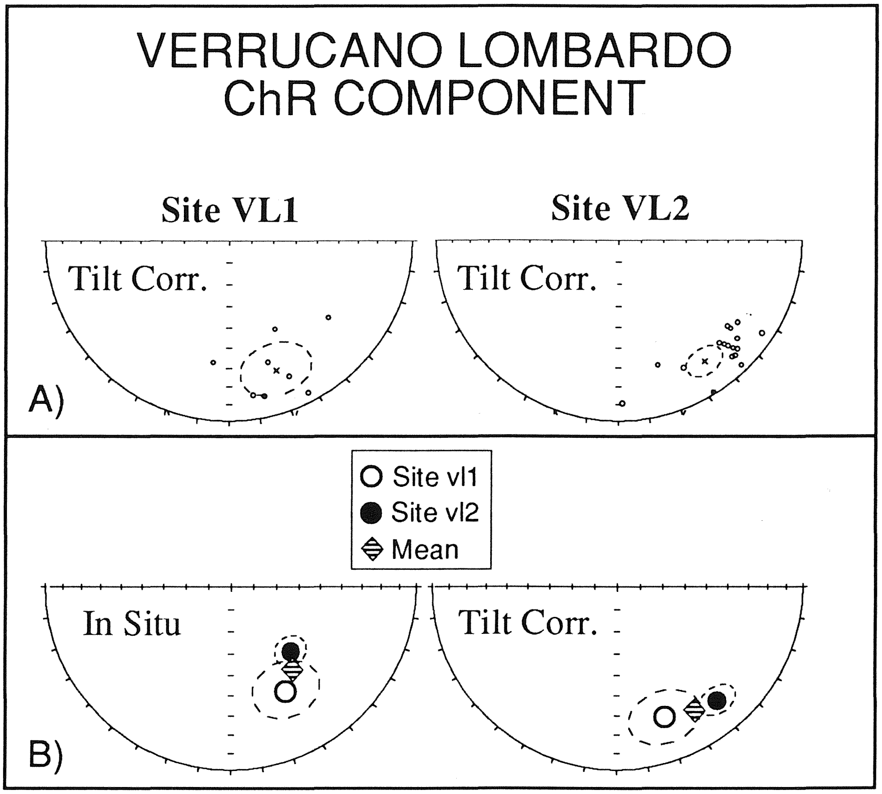
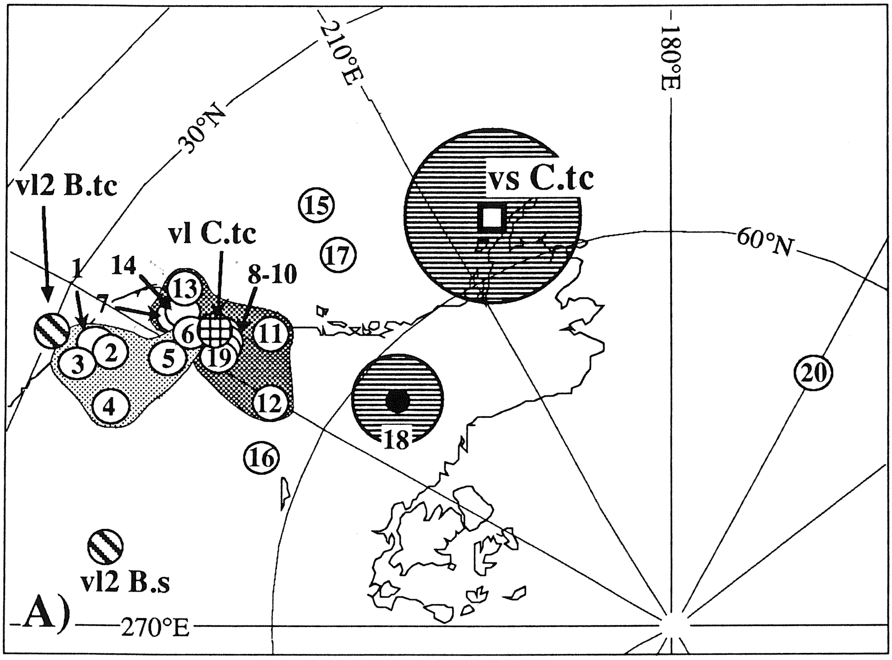


Fig. 6 - Stereographic projections of (A) the tilt corrected characteristic remanence detected in the Verrucano Lombardo Ss. sites, provided with the a95 cone of confidence around the mean and of (B) the mean direction of the characteristic remanence of each site before and after correction for tilting.

CONCLUSIONS

A high unblocking temperature characteristic component isolated in the Upper Permian Verrucano Lombardo Sandstones of Val Camonica, Lombardy yielded a Virtual Geomagnetic Pole in agreement with the Permian portion of both the «African» and the rotated European Apparent Polar Wander Paths (APWPs). A tentative Southern Alps APWP for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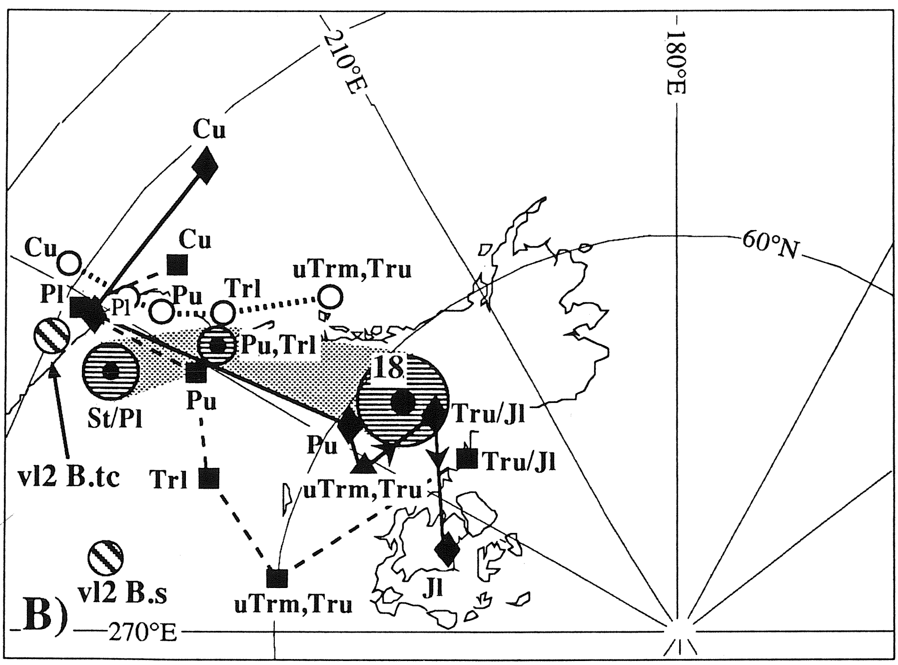
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Cu
uTrm,Tru
Pl
Pl
Pu
Trl
Pu,Trl
18
St/Pl
Pu
Tru/Jl
Pu
Tru/Jl
vl2 B.tc
Trl
uTrm,Tru
vl2 B.s
uTrm,Tru
Jl
B)

the Stephanian (Late Carboniferous) to Late Anisian (Middle Triassic) time interval is constructed based on these and literature data.

More controversial is the interpretation of a lower unblocking temperature "B" component isolated in the Verrucano Lombardo Ss. and of the characteristic component observed in the Upper Triassic Val Sabbia Sandstones. With the aim to extend the Southern Alps APWP to more recent times (i.e., to the Triassic), further analyses are requested to resolve open problems such as (i) the presence of a possible syn-folding remagnetization affecting the Middle Triassic Prezzo Limestone (pole 18, see note 2), (ii) the poorly constrained age and statistics of the characteristic component isolated in the Val Sabbia Ss. and (iii) the meaning of the Verrucano Lombardo "B" component. These preliminary results encourage to devote some efforts to the paleomagnetism of the Permian to Triassic sedimentary sequence of the western Southern Alps.

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Fig. 7 - (A) Geographic projection of:
1) The Permian to Triassic poles from the Southern Alps (tab. 2). Poles enclosed in light shadowed pattern are Stephanian to Lower Permian, poles in dark shadowed pattern are mainly Upper Permian, with the exception of pole 13 (Scythian) and 19 (Ladino-Carnian). Poles 14 and 15 are Permian to Triassic and poles 16, 17, 18, 19 and 20 are Triassic. 2) The VGP calculated from the (i) VL Ss. tilt corrected characteristic remanence (*vl C.tc*), (ii) the in situ and tilt corrected "B" component detected in VL Ss. site VL2 (*vl2 B.s* and *vl2 B.tc*, respectively) and (iii) the Val Sabbia Ss. tilt corrected characteristic remanence (*vs C.tc*).
(B) Geographical projection of:
1) The U. Carboniferous to L. Jurassic portion of the APWP of Van der Voo (1993, tab. 5.8) for W Gondwana in the coordinate system of NW Africa (bold curve and diamonds). 2) The U. Carboniferous to L. Jurassic portion of the APWP of VAN DER VOO (1993, tab. 5.3) for Gondwana in the coordinate system of NW Africa (dashed curve and squares). 3) The U. Carboniferous to U. Triassic portion of the APWP of VAN DER VOO (1993, tab. 5.1) for stable Europe rotated to African coordinates (dashed curve and circles). 4) Tentative Stephanian (U. Carboniferous) to U. Anisian (Middle Triassic) APWP based on data from the Southern Alps (dotted band). Striped circles are a63 cones of confidence about the poles. Age symbols are as follows: Cu: Upper Carboniferous; St/Pl: Stephanian (Upper Carboniferous)/Lower Permian; Pl: Lower Permian; Pu: Upper Permian; Trl: Lower Triassic; uTrm, Tru: upper Middle Triassic, Upper Triassic; Tru/Jl: Upper Triassic/Lower Jurassic; Jl: Lower Jurassic. The ages are based on the DNAG time scale (PALMER, 1983).

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Author's address:

GIOVANNI MUTTONI, Dipartimento di Scienze della Terra, Università di Milano, via Mangiagalli 34 - 20133 MILANO