

**PALEOMAGNETIC STUDY OF UPPER CRETACEOUS AND TERTIARY
FORMATIONS FROM THE CENTRAL ANDES
(Southern Ecuador and Peru)**

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Résumé

Le long de la cordillère andine, environ 2 000 échantillons provenant de 195 sites paléomagnétiques d'âge crétacé supérieur et cénozoïque, répartis entre le sud de l'Equateur et le sud du Pérou, ont été prélevés. Les données obtenues montrent la présence de rotations horaires au nord de la déflexion de Huancabamba, et antihoraires au sud. Ces rotations sont en partie récentes (post-oligocène inférieur). La remarquable cohérence de la rotation antihoraire au Pérou plaide en faveur de l'hypothèse d'une rotation d'ensemble de la cordillère occidentale.

Key words : Paleomagnetism, Central Andes, Cretaceous, Cenozoic.

Abstract

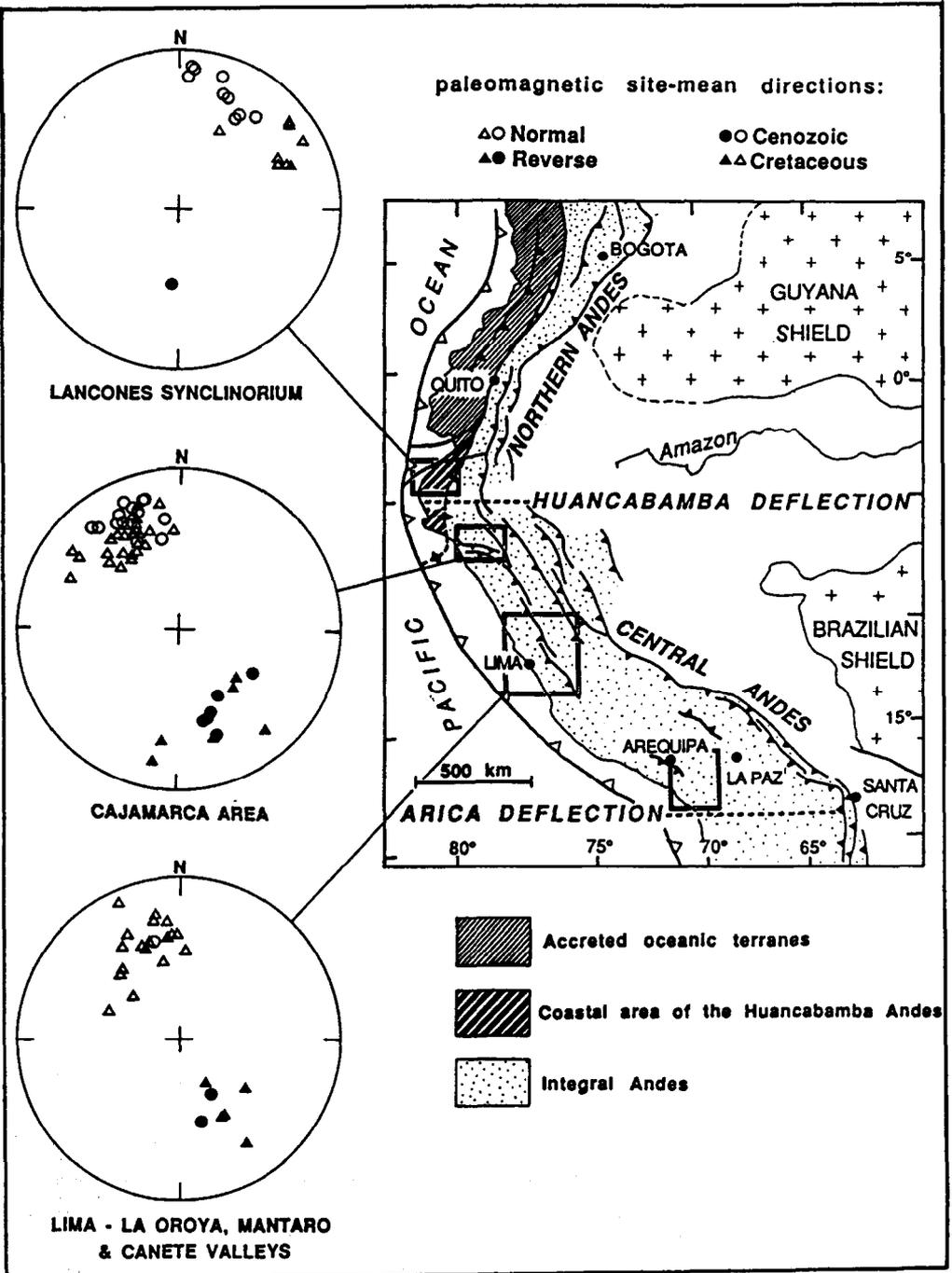
The Central Andes have been considered as a typical marginal orogen, related exclusively to the subduction of the Pacific plate. They differ from the Northern and Southern Andes by the lack of any ophiolitic suture and by the presence of some major bends in the cordillera, known as the Huancabamba and Arica deflections. We present new paleomagnetic results we obtained from upper Cretaceous and Tertiary formations north of the Huancabamba deflection, in southern Ecuador and northern Peru (Lancones basin), and south of it, in the Cajamarca area, in central and southern Peru, just north of the Arica deflection.

About 2000 cores from over 195 sites were sampled in these regions, in upper Cretaceous to upper Miocene sedimentary, volcanic and intrusive formations. The location of the sampled regions is shown in the Figure. North of the Huancabamba deflection, in the Lancones synclinorium, Albian to Senonian volcanics (9 sites) and Paleogene intrusive bodies (11 sites) were sampled. South of the Huancabamba deflection, in the Cajamarca area, 42 sites were sampled in the black limestones of the Middle Albian Pariatambo formation, 12 sites in the slightly deformed Paleocene-Lower Eocene volcanic Llama formation, 7 sites in the overlying undeformed Upper Eocene-Early Oligocene Huambos volcanic formation, and 5 sites in some Middle Eocene intrusive granodioritic bodies. Southward, we have sampled 55 sites, mainly in Albian but also in Eocene and Miocene formations, along three E-W transverses (Lima-La Oroya, Mantaro and Canete valleys), running from the coastal area to the Eastern Cordillera. Those sites are not all studied yet. Finally, the analysis of 50 additional sites, sampled in southern Peru, is presently in progress.

In most of the studied samples, a stable characteristic component of magnetization is isolated after thermal heating beyond 200-300°C. This stable component is used to calculate a mean direction for each site. In order to interpret our data in term of deformation, we have referred the mean regional directions to the Upper Cretaceous pole defined by Beck (1988) for stable South America, and to a 40 Ma pole that we have calculated averaging Lower Tertiary and Miocene published poles. The results obtained from each region are shown on the Figure and the values of R and F (rotation and latitudinal drift with respect to the stable continent respectively) are reported in the Table.

One can immediately notice that the observed rotations are in opposite senses north and south of the Huancabamba deflection, independently of the age of the studied formations.

- North of the deflection, the clockwise rotation has occurred partly during the Uppermost Mesozoic-Lowermost Cenozoic, and partly later than Paleocene. It has been shown (Mourier et al., 1986; Laj et al., 1989) that these rotations succeed to a previous one recorded by the pre-Albian basement.



- South of the Huancabamba deflection, the results obtained from the Cretaceous formations of the Cajamarca area and the E-W transverses, consistently show that both regions have undergone an anticlockwise rotation of about 25-28° since Upper Cretaceous. This is in agreement with other published results obtained farther East (Kono et al., 1985). This rotation is only slightly larger than the one obtained from the Tertiary formations of the Cajamarca area. Thus, at least in this region, most of this anticlockwise rotation has occurred later than Early-Oligocene. Only 7 Tertiary sites out of 11 have been studied right now along the three E-W transverses. Only three of them show reliable paleomagnetic results which are also consistent with the Cretaceous ones.

The results obtained from tertiary formations and reported here thus document an unpredicted pattern of post-Paleocene clockwise and post-Early Oligocene counterclockwise rotations north and south of the Huancabamba deflection, respectively (Mitouard et al., 1990). The clockwise rotations north of the Huancabamba deflection are probably related to the distributed shear regimes documented by geological studies. South of the deflection, on the contrary, no large-scale strike-slip faulting has been observed, and the remarkable consistency of the results over such a large area indicate that the observed anticlockwise rotations more realistically indicate a rotation of the entire Peruvian margin.

This latter rotation, the timing of which needs to be better constrained between Early-Oligocene and Present, could be related to the uplift of the Central Andean Plateau, in agreement with a recent published model (Isacks, 1988). When combined with this model, the data obtained here suggest that the amount of shortening in the Central Andes is greater but of the same order of magnitude than the one documented by geological studies (Sheffels, 1988).

Additional data from southern Peru will be discussed and compared to the former results from the Central Andes.

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Region	Albian			Tertiary			
	N	R ± ΔR	F ± ΔF	Period	N	R ± ΔR	F ± ΔF
Lancones Basin southern Ecuador	9	+ 63.5 ± 7	18.3 ± 7.6	Tpa	10/11	+ 24.7 ± 11.6	4.3 ± 16.6
.....Huancabamba deflection.....							
Cajamarca area	34/42	- 28 ± 6	19 ± 6.9	Tpa to Early To	20/24	- 19 ± 9.7	1.6 ± 15
E - W Transverses	23/44	-25 ± 7.6	15.5 ± 8.6	Te - Tm	3/11	-13 ± 16.2	8.7 ± 17.2

Table: Results obtained from Cretaceous and Tertiary formations in southern Ecuador and in Peru. The location of the sampled regions is shown in the figure. R is positive or negative when the rotation is clockwise and anticlockwise respectively. N: number of sites. Tpa: Paleocene; Te: Eocene; To: Oligocene; Tm: Miocene (18 Ma)