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Paleomagnetism and suspect terranes of the North American Cordillera

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This map is preliminary and has not been reviewed for conformity with Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

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Introduction

The north American Cordillera, west of the miogeoclinal margin, is a collage of suspect terranes. These terranes are fault bounded geological entities characterized by internal stratigraphies and geological histories that are different from those of surrounding terranes. In addition, suspect terranes cannot be easily related in a paleogeographic sense through facies changes to the Cordilleran miogeocline (Coney, and others, 1980). Paleomagnetic studies on rocks from within these suspect terranes commonly yield discordant directions that imply significant tectonic translations and/or rotations (Beck, 1976, 1980). Although allochthoneity is not implicit when a terrane is labeled as suspect, the paleomagnetic data in conjunction with paleobiogeographic evidence strongly suggest that the present architecture of the western Cordillera is the result of a complex history of terrane motion, accretion, and post-accretion or intraplate disruption. Paleomagnetic poles from suspect terranes must be treated as terrane-specific or amalgam-specific data. This includes nearly all of the paleomagnetic data from Mexico which comes from terranes whose Paleozoic and Mesozoic histories are poorly understood.

The timing of accretion, defined paleomagnetically as the age of attainment of relative latitudinal stasis, must be reconciled with geological evidence from overlap assemblages, deformed flysch sequences, and igneous and metamorphic events.

The purpose of this map is to document all known reliable paleomagnetic directions from Cordilleran suspect terranes and to portray their concordance or discordance with respect to directions predictd from "stable" North America. The map is intended not as a final synthesis, but as a working base on which new data points can be added and from which the motion histories of various terranes can be interpreted. The map is also useful in conveying the extent of our present knowledge and illustrating where future work might be directed. There are numerous terranes for which no paleopoles are available. This, of course, is in part due to the lack of suitable rock types in some terranes for paleomagnetic analysis, but in other cases, such as the Mexican terranes there is a clear need for intensified research. An ultimate goal of individual apparent polar wander (APW) paths for each terrane is unrealistic, but in conjunction with absolute plate motion studies, the motion histories of suspect terranes can be reconstructed and a dynamic history of Cordilleran growth can be developed.

Discussion of Map

The geographic base used for this map was the 1:5,000,000 scale Tectonic Map of North America (King, 1969). Suspect terrane boundaries were taken from Jones, and others (1981), Berg, and others (1980), Coney (1981), Campa and Coney (1983), M. C. Blake, D. G. Howell, D. L. Jones (written comm., 1982), J. W. H. Monger (written comm., 1982), and N. J. Silberling (written comm., 1982). The reader is urged to consult these sources for terrane names and boundaries not shown on this map and for discussions of terrane stratigraphies.

Also shown are major sedimentary and volcanic overlap assemblages and plutonic complexes that hide significant parts of terrane boundaries. Other overlap assemblages are left off for cartographic simplicity, but paleomagnetic directions from such assemblages are generally listed in the table under the terrane within whose projected boundaries the study site would be included. For example, numbers 10 and 11 are listed under Wrangellia even though they represent data from overlap assemblages. This simply reflects present geography rather than any tectonic model.

Paleomagnetic directions are shown graphically at each locality by two vectors. The thinner vector represents the expected direction calculated from the list of North American reference poles in Irving and Irving (1982)[1/]. The azimuth of the vector represents declination and the vector length is arbitrary (although generally 15 mm). The thicker vector represents the observed direction with azimuth portraying declination and length reflecting inclination relative to an expected value. Discordancy in observed mean inclination is scaled linearly such that 1mm in length is equivalent to 2^o in inclination. Too shallow inclinations (i.e., + F values) are represented as longer vectors and vice-versa. For example given and expected inclination of 40^o and an observed inclination of 30^o then the observed vector length is drawn $\frac{40^o - 30^o}{2^o\ /mm}$ = 5mm longer than the expected direction vector.

In most cases, the positive inclination direction for a given study is portrayed on the map, however, the actual observed direction is listed in the table.

At some localities, multiple observed direction vectors are shown for a single expected direction (e.g., #15). These represent multiple results from rocks of both temporal and geographic proximity but with directions too divergent to meaningfully average. In some cases, this divergence is primarily in declination and this may be attributable to "real" block rotations. In a few cases, however, the same age rocks show very divergent inclinations which is somewhat puzzling. We consider the latter to be suspect paleomagnetic results from suspect terranes.

A series of numbers and letters next to each vector set indicate respectively: (1) reference number for the table, (2) approximate age in million years, and (3) acknowledgment of statistical concordancy with the expected direction in either the rotation value "Cr," the flattening value "Cf," or both "Crf." Conventions and equations for calculating the concordance/discordance statistics are the same as those presented by Beck (1980). Clockwise rotations are positive, counterclockwise are negative, and declinations are considered discordant when $R > \Delta R$. Too shallow (i.e., flattened) inclinations are positive, too steep are negative, and inclinations are considered discordant when $F > \Delta F$. All directions shown in this compilation have been corrected for local structures in the individual study areas so that significant R and F values are considered to reflect rigid-body rotation and/or translation.

[1/] Reference poles for Paleozoic directions from the Alexander terrane were taken from Van der Voo, and others (1980) and from Van der Voo and French (1974).

The table on the map provides all of the necessary values for evaluation of concordance/discordance statistics. In a few cases, mean directions were recalculated from original data or were calculated from the virtual geomagnetic pole (VGP) position. Individual studies are grouped by terrane or by some other convenient assemblage (e.g., Trans-Mexican volcanic belt) and are listed by age from youngest to oldest.

In screening the paleomagnetic literature we applied only general criteria for the acceptance of a direction as "reliable:"

1) No data from abstracts.
2) The age of the rocks studied to yield a paleopole had to be known within ± 10 million years.
3) Alpha-95 had to be less than 20^{o}.
4) Description of sampling procedure and/or statistical parameters (i.e., k values) indicating that secular variation had been averaged.
5) Demonstration of standard demagnetization techniques.

A northern hemisphere origin is assumed in all calculations of the concordance/discordance values except where we considered there to be compelling evidence to the contrary. Using the data provided in the table, it is a simple task to recalculate flattening values ($F \pm \Delta F$) if a southern hemisphere origin is preferred. ΔF does not change so that all one needs to do is double the absolute value of I_o and add this to the F value given in the table. The latitudinal discrepency indicated by discordant inclination values may be calculated from the data in the table and the dipole equation:

$$\tan I = 2 \tan \theta$$

I is inclination (either I_x or I_o) and θ is paleolatitude (θ_x or θ_o respectively). The latitudinal translation would then be $|\theta_x - \theta_o|$.

Note: Vector pair "77" represents data from Wells, (1982):

No.		Age	λ s	ϕ s	D^o	I^o	α 95
77	Crescent Formation S.W. Washington	Eocene	46.5	123.5	42.0	59.8	7.6

Ref. pole age	D_x	I_x	A_{95}	$R \pm \Delta R$	$F \pm \Delta F$
50 m.y.	351.6	66.0	4	51.5 ± 16.5	8.5 ± 8.1

Other data from Wells (1982) was unfortunately omitted for cartographic simplicity.

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