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Article

Distinguishing Mélange-Forming Processes in Subduction-Accretion Complexes: Constraints from the Anisotropy of Magnetic Susceptibility (AMS)

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The AMS measurements consisted of turning each specimen in 15 different positions, during which the low-field susceptibility was detected in order to reconstruct the susceptibility ellipsoid and to recover the relative abundance and spatial distribution of its para- and ferromagnetic minerals [100–101].

The magnetic fabric of rocks is geometrically modelled as an ellipsoid, whose axes $k_1 > k_2 > k_3$ correspond respectively to the principal directions of maximum, intermediate, and minimum susceptibility.

The shape of the magnetic ellipsoid is described through the ratios between the magnitude of the susceptibility axes, such as the magnetic lineation ($L = k_1/k_2$), the magnetic foliation ($F = k_2/k_3$), and the shape parameter, $T = 2\ln(k_2/k_3)/\ln(k_1/k_3) - 1$, which also defines its oblateness/prolateness [99]. The corrected anisotropy degree, $Pj = \exp\sqrt{2\sum_{i=1}^{3}(\ln k_i - \ln k_m)^2}$, expresses the eccentricity and stretches of the AMS ellipsoid [102].

Instead, the directions of the principal susceptibility axes were correlated to the emplacement mechanisms and structural setting (i.e., the force acting during eventual deformation history of the rock). In particular, the k_3 axis was perpendicular to the magnetic foliation plane, which contained k_1 and k_2 axes, with the k_1 direction being parallel to the magnetic lineation. As an example, in depositional settings, magnetic foliation is expected to be close to the bedding plane [109]. In a tectonic setting, the AMS ellipsoid is commonly coaxial, with the strain ellipsoid of k_1 and k_3 being sub-parallel respective to the axis of maximum stretching and maximum shortening strain (e.g., [101–103]).

The guidelines for the magnetic fabric analysis and interpretation [98,101,103–105] rely on AMS ellipsoid shape and L and F distribution, providing two magnetic fabric end-members with several composite intermediate stages (type B1, B2, and B3 in Figure S1A–C):

- Sedimentary fabric (type A in Figure S1A–C), either purely depositional or related to compaction, characterized by an oblate ellipsoid ($k_1 \approx k_2 >> k_3$; $0 > T \geq 1$; $F > L$). The magnetic foliation was well-defined and parallel to the bedding plane or making an angle < 15°. The magnetic lineation (k_1 axes) were scattered in this plane or eventually gathered in a cluster consistent with paleo-current directions;
- Tectonic fabric generally showed a prolate ellipsoid ($k_1 >> k_2 \approx k_3$; $-1 \leq T < 0$; $L > F$) (type C3 in Figure S1A–C), associated with incipient deformation. The increasing strain induced the clustering of k_1 axes in the direction of maximum stretching and progressive deviation of k_3 axes from a direction perpendicular to the bedding plane toward the maximum compressive stress direction (Figure S1B). The shape of ellipsoid changed in the case of high tectonic imprint becoming oblate with magnetic foliation parallel to the schistosity (see type C1 in Figure S1A–C).

The high sensitivity of AMS to incipient strain caused the development of several composite intermediate stages of magnetic fabric (type B1, B2, and B3 in Figure S1A–C), such as sedimentary fabric with a marked tectonic imprint characterized mainly by a triaxial ellipsoid ($k_1 > k_2 > k_3$).

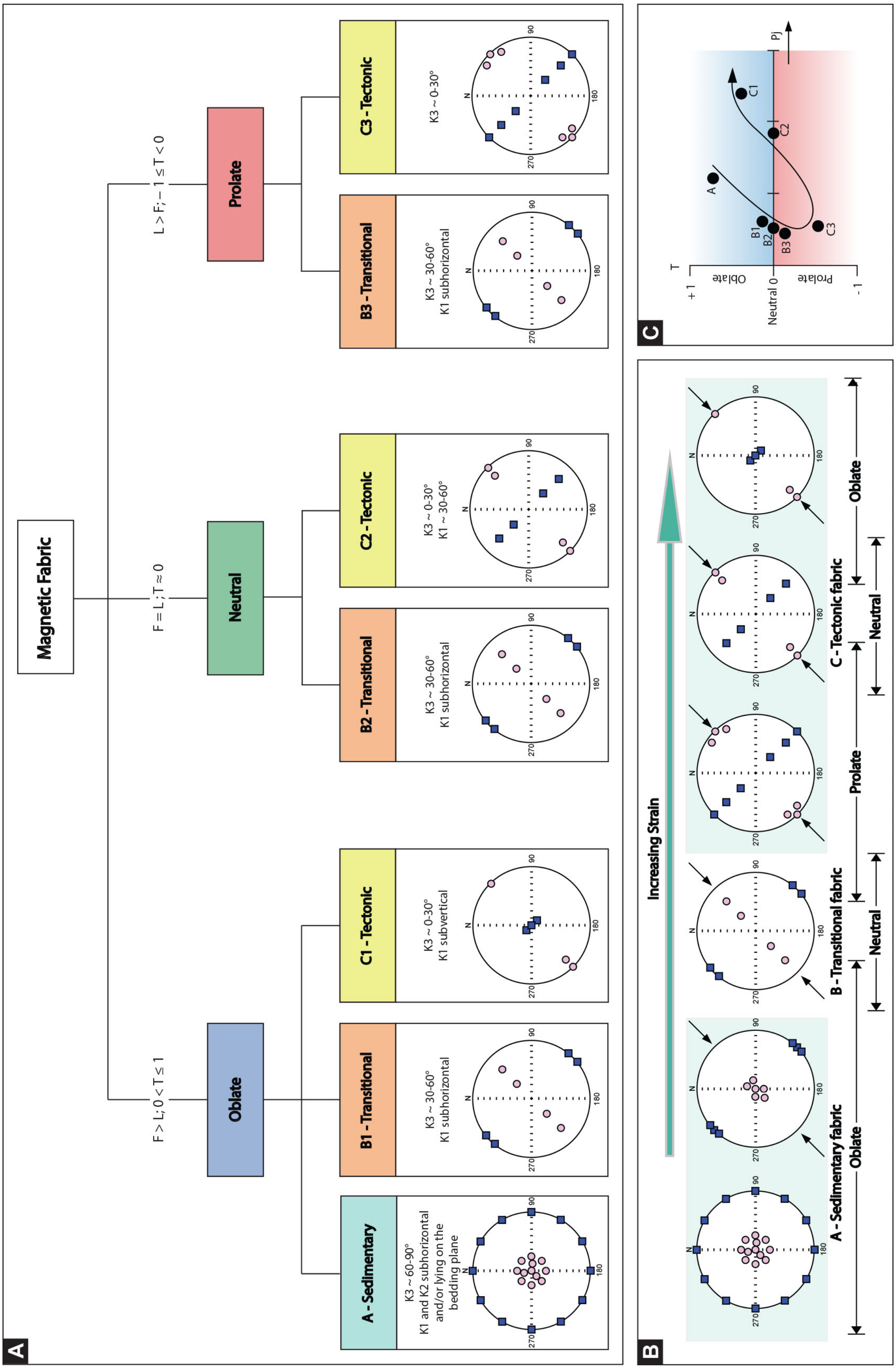

Figure S1. (**A**) Conceptual diagram for the magnetic fabric discrimination into sedimentary (type A), transitional (type B1, B2, and B3), and tectonic (type C1, C2, and C3), on the basis of the shape and principal axis of the AMS ellipsoid. (**B**) Main steps of the magnetic fabric changing from sedimentary (type A) to tectonic (type C) due to the progressive increase of (modified from [105]). (**C**) Jelinek plot (shape parameter vs corrected anisotropy degree), showing the AMS path generally followed by the magnetic ellipsoid during the deformation increase (modified from [105]).