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

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Abstract: The strong morphological similitude of the block-in-matrix fabric of chaotic rock units (mélanges and broken formations) makes problematic the recognition of their primary forming-processes. We present results of the comparison between magnetic fabric and mesoscale structural investigations of non-metamorphic tectonic, sedimentary, and polygenetic mélanges in the exhumed Late Cretaceous to early Eocene Ligurian accretionary complex and overlying wedge-top basin succession in the Northern Apennines (northwest Italy). Our findings show that the magnetic fabric reveals diagnostic configurations of principal anisotropy of magnetic susceptibility (AMS) axes orientation that are well comparable with the mesoscale block-in-matrix fabric of mélanges formed by different processes. Broken formations and tectonic mélanges show prolate and neutral-to-oblate ellipsoids, respectively, with magnetic fabric elements being consistent with those of the mesoscale anisotropic "structurally ordered" block-in-matrix fabric. Sedimentary mélanges show an oblate ellipsoid with a clear sedimentary magnetic fabric related to downslope gravitational emplacement. Polygenetic mélanges show the occurrence of a cumulative depositional and tectonic magnetic fabric. The comparison of field and laboratory investigations validate the analysis of magnetic features as a diagnostic tool suitable to analytically distinguish the contribution of different mélange forming-processes and their mutual superposition, and to better understand the geodynamic evolution of subduction-accretion complexes.

Keywords: mélanges; AMS; magnetic fabric; diagnostic criteria; Ligurian accretionary complex; Northern Apennines

1. Introduction

Chaotic rock units, including mélanges and broken formations, are significant components of different modern and ancient subduction complexes around the world, showing different block-in-matrix fabrics that reflect a close relationship between the forming-process and the structural position acquired during their formation [1,2]. Highly sheared and disrupted tectonic mélanges and broken formations characterize the subduction plate boundary and/or associated megathrust shear zones, as well as out-of-sequence thrust faults in subduction complexes (e.g., [3–10]). Sedimentary mélanges or heterogeneous mass-transport deposits occur from slope instability in the upper part of frontal wedges of subduction–accretion complexes and in the trench inner-slope (e.g., [11–28]). Diapiric mélanges, including shale and mud diapirs, occur as the result of the upward rise of overpressured fluids