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Characterization of coexisting NH_4- and K-micas in very low-grade metapelites

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ABSTRACT

Organic-rich Carboniferous shales with associated coal seams, from the *Bacia Carbonífera do Douro-Beira* (north Portugal), have been studied by TEM as well as by a variety of other methods. NH_4 and K micas and berthierine form small subparallel packets of a few layers separated by low-angle boundaries. One- and two-layer ordered polytypes, with some spot enlargement typical of minor disorder, occur in the NH_4 micas (i.e., metamorphism tobelites). They exhibit all the characteristics commonly described for sub-greenschist-facies, including a lack of textural and chemical equilibrium. The compositions of the 2:1 layers vary considerably for both K- and NH_4-micas, and except for Ti, exhibit similar compositional ranges. The most significant compositional variations are explained by phengitic substitution (Si from 3 to 3.25, Fe + Mg from 0.1 to 0.3), but no evidence of an illitic substitution has been found. NH_4 in tobelites was determined by analysis of NH_3 using Nessler's reagent, basal spacing, and 1–(K + Na). The resulting values indicate NH_4 contents ranging from 30 to 59% of the interlayer site occupancy. At very low temperatures of metamorphism (e.g., North Sea), the intergrowths of NH_4 and K in micas is on the nanometer-scale. With an increase in temperature (e.g., Pennsylvania), NH_4- and K-micas are present as different minerals. The Douro-Beira samples represent a still higher-temperature case and, therefore, NH_4 and K can be present in the same interlayer sheet but with one cation being dominant. NH_4- and K-dominated micas have segregated into well-separated packets with scarce intergrowths and almost no mixed-layers. Hence they show a solvus relationship.