
The Kinetics of the Smectite to Illite Transformation in Cretaceous Bentonites, Cerro Negro, New Mexico

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Abstract: The thermal effects, as well as the survivability and origins of microorganisms in Cretaceous rocks, are evaluated from the timing and extent of the smectite to illite transformation in Cretaceous bentonites collected from cores outside the thermal aureole of the Pliocene Cerro Negro volcanic neck. Overall, randomly ordered mixed-layered illite-smectite (I-S) is the predominant clay mineral in these bentonites, and the K-Ar ages of I-S range from 36 to 48 Ma (21 analyses, two additional analyses were outside this range). Increased temperature from burial is thought to be the primary factor forming I-S in these bentonites. Kinetic model calculations of the smectite to illite transformation are also consistent with I-S formed by burial without any appreciable thermal effects due to the emplacement of Cerro Negro. In a core angled toward Cerro Negro, the percentages of illite layers in I-S from the bentonite closest to Cerro Negro are slightly higher (32– 37%) than in most other bentonites in this study. The K-Ar ages of the closest I-S are slightly younger as a group (38– 43 Ma; Average 41 = Ma; N = 4) than those of I-S further from Cerro Negro in the same core (41– 48 Ma; Average = 44 Ma; N = 6). A small amount of illite in this I-S may have formed by heat from the emplacement of Cerro Negro, but most illite formed from burial. Vitrinite reflectance, however, appears to record the effects of heating from Cerro Negro better than I-S. Tentatively, the temperature of this heat pulse, based on vitrinite data alone, ranged from 100 to 125° C and this is most evident in the CNAR core. The upper temperature, 125° C approximates the sterilization temperatures for most microorganisms, and these temperatures probably reduced a significant portion of the microbial population. Thermophiles may have survived the increased temperatures from the combined effects of burial and the intrusion of Cerro Negro.

Key Words: Bentonite • Cerro Negro • Cretaceous • Illite • I-S • K-Ar • Kinetics • Microorganisms • New Mexico • Smectite

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