Economic Geology
Vol 94, 1999, pp. 1353-1366

Oxygen and Hydrogen Isotope Composition of Kaolinite Deposits, Cape Peninsula, South Africa: Low-Temperature, Meteoric Origin

CHRIS HARRIS, JOHN S. COMPTON, AND SALLY A. BEVINGTON
Department of Geological Sciences, University of Cape Town, Rondebosch 7700, South Africa

Abstract

Economic kaolinite deposits of the Cape Peninsula, South Africa, formed by in situ alteration of silicates (mainly feldspar phenocrysts) in the Peninsula Granite. Kaolinite-bearing ores contain an average of 30 wt percent kaolinite. X-ray diffraction and chemical data show that the <38-μm fraction of the ore is predominantly kaolinite, with 7 to 29 wt percent illite and 0 to 6 wt percent quartz. The bulk <38-μm fraction of samples collected from various localities on the Cape Peninsula have δD and $\delta^{18}O$ values that range from –60 to –50 and 18.0 to 20.2 per mil, respectively. The δD and $\delta^{18}O$ values of >2-mm kaolinite grains and the <38-μm fraction (which is mainly kaolinite) range from –59 to –50 and 20.2 to 21.9 per mil. The δD and $\delta^{18}O$ values of the associated illite are estimated to be –90 and 12 per mil, respectively. Kaolinite shows no systematic variation in isotopic composition from the surface to the bottom of the 30-m-deep open pit at the Noordhoek mine. The similarity of the calculated isotopic composition of the fluid in equilibrium with the kaolinite at 20°C and the measured isotopic composition of ambient meteoric water suggests that the kaolinite formed by low-temperature meteoric weathering. The intracrystalline fractionation factor ($a_{nonOH/OH}$) determined for a single kaolinite sample is 1.028 ± 0.001 and confirms a low-temperature origin of the kaolinite. The illite did not form in isotopic equilibrium with the kaolinite and most likely formed by fluid interaction with the granite at higher temperatures, probably during magmatic-hydrothermal alteration soon after emplacement of the pluton. The kaolinite deposits may have developed preferentially in hydrothermally altered zones of granite.