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Interstratification of graphene-like carbon layers within black talc from Southeastern China: Implications to sedimentary talc formation

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Abstract

Large deposits of unusual black talc interstratified with dolostone layers of the late Neoproterozoic Dengying Formation were discovered in Guangfeng County, Jiangxi Province, southeastern China. The black talc ore exhibits primarily oolitic structures and consists mainly of talc (30–70 wt%), dolomite, and quartz, with trace amounts of pyrite and apatite. The ooids are composed of nearly pure black talc crystals, most of which consist of ultrafine nano-plates. The black talc contains small amounts of carbon, which causes the black coloring. Raman spectra and X-ray photoelectron spectroscopy (XPS) results indicate structural disorder and chemical impurities within bonds (e.g., sp^3 hybridized carbon and C–O bonds) in the carbonaceous material, instead of perfectly structured graphite or graphene. Isolated graphene-like carbon interlayers are present in the talc nano-crystals, as shown by Z-contrast transmission electron microscope (TEM) imaging. Based on previous studies on Mg-silicate precipitation from surface water, we propose a sedimentary formation mechanism for the black talc, in which tetrahedral–octahedral–tetrahedral (T-O-T) layers of Mg-silicates, 1~2 unit-cells thick, co-precipitated with abundant organic matter derived from microorganisms thriving in locally Al-depleted sea water with high concentrations of Mg^{2+} and SiO_2 (aq), in a shallow marine or lagoonal environment. The involvement of organic matter may have facilitated the precipitation of Mg-silicate. Further diagenesis and re-crystalliztion of the biomass-coated precursor resulted in the formation of graphene-like layers between neighboring talc nano-crystals with same orientation.

Keywords: Black talc, graphene-like carbon, interstratification structure, sedimentary talc