The Urey reaction and the continental crust as a sink for global carbon

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Harold Urey (Proc. Nat. Acad. Sci. **479**, 241, 1952) introduced the reaction that now bears his name, to explain the origin of carbon in the continental crust. The reaction extracts CO_2 from the atmosphere through acid rain that reacts with calcium silicates; the products are transported to the oceans, where organic or inorganic processes result in the deposition of carbonates. Carbonates are the primary long-term storage reservoir of carbon in the continental crust. The origin of the CO_2 making up much of the current carbonate mass can be (1) the early atmosphere or (2) the mantle. The Urey reaction would scavange almost all the atmospheric CO_2 that survives the formation of the Earth. If surface volcanism introduces more CO_2 to the surface than is returned to the mantle by subduction, the CO_2 entering the atmosphere would be removed, and added to the continental crust, by the Urey reaction. In order to quantify the rate at which the Urey reaction removes CO_2 from the atmosphere, we utilize data from the Paleocene-Eocene thermal maximum (PETM). This was a period of elevated global temperature (4° to 5° C) at 56 Ma, attributed to a pulse of volcanism in the north Atlantic. The decay time of this thermal anomaly allows us to quantify the rate at which CO_2 is extracted from the atmosphere by the Urey reaction. We relate this characteristic time to the mass of carbon in the atmosphere and the flux of volcanic carbon entering the atmosphere and find consistent results.