Ancient Landscapes and the Co-Evolution of Microbial Nitrification

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Parent materials are important in pedogenesis and in determining the physiochemical properties influencing microbial biogeochemical cycles in soil. Nitrification, the aerobic oxidation of ammonia to nitrate, has been central to the global biogeochemical nitrogen cycle since the time when the Earth was first oxygenated. Ammonia oxidizing archaea (AOA) and bacteria (AOB) drive nitrification and their population dynamics impact directly on the global nitrogen cycle. AOA predominate in the majority of soils but an increasing number of studies have found that nitrification is largely attributed to AOB. The reasons for this remain poorly understood. Here, amoA gene abundance was used to study the distribution of AOA and AOB in agricultural soils on different parent materials and in contrasting geologic landscapes across Australia (n=135). AOA and AOB abundances separated according to the geologic age of the parent rock with AOB higher in the more weathered, semi-arid soils of Western Australia. AOA dominated the younger, higher pH soils of Eastern Australia. This differentiation reflects the age of the underlying parent material that has implications for our understanding of global patterns of nitrification and soil microbial diversity. Western Australian soils are derived from weathered archaean laterite and are acidic and copper deficient. Copper is a co-factor in the oxidation of ammonia by AOA but not AOB. Thus, copper deficiency could explain the unexpectedly low populations of AOA in Western Australian soils.