THERMAL DISTURBANCE CAUSED BY ALTERATION OF CRYSTALLINE ROCKS GUY VASSEUR1 1. Sorbonne Universités, UPMC Univ. Paris 06, CNRS, EPHE, UMR 7619 METIS, 4 place Jussieu, F75005, Paris, France
Abstract n°2631

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KEYWORDS: Stratified Fissured Layer, Heat Generation, Temperature

In crystalline rocks, a weathering profile is composed of stratiform layers following the palaeotopography. Below the upper unconsolidated layer (saprolite), the permeable layer is a fissured zone where horizontal fractures are generated by tensile stress induced through by swelling of some minerals. This chemical reaction is exothermic with heat E released per unit volume on the order of 0.5 GJm-3.What is the expected temperature increase? The present 1D thermal model aims to discuss the conditions under which a substantial temperature increase can develop. Since the enthalpy of the weathering reaction E (in Jm-3) is finite, the heat is generated only during a limited time (Dt) at an average rate A (in Wm-3) = E Dt as imposed by the kinetics of the chemical reaction. The continuing nature of the reaction requires that the chemical front propagates downward with a velocity V into intact rock, furnishing new fuel. The thickness a of the active zone is a=VDt so that the volumic heat generation rate becomes A=EV a. With the conductive 1D heat equation, the relevant parameter is the “integrated heat” Aa=EV which has the dimension of a heat flow and where Dt is absent. Only when EV is comparable with the natural geothermal heat flow q (about .1Wm-2), does its thermal effect become significant. According to the V value, two cases are considered- _ V is low and consistent with the erosion rate. A steady state is maintained. For V=10m My=3.10-13 ms-1 , EV=1.5 10-4 Wm-2 (~0.0001q) which induces negligible thermal effects. _ V is much larger, say 1mm y=3 10-10 ms-1. This leads to EV=1.5 10-1 Wm-2 (~0.1q) and corresponds to substantial temperature increase. Such extreme V value can only occur for very limited time. Therefore any thermal disturbance associated with weathering implies a very transient and or local phenomenon.