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Development of surface paleothermometry using thermoluminescence

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Reconstructing past temperature enable to predict past variability in climate. Trapped charge phenomenon in crystal lattice, due to ambient radioactivity, e.g. thermoluminescence (TL) has the potential to predict past temperature because the resident time of trapped electron is temperature dependent. TL signals from feldspar arise from a series of traps having a resident time at room temperature ranging from <a to >Ba. Trapped electrons associated with higher temperature TL (>300 ˚C) or deeper traps are suitable for dating application, as trapped electrons are least sensitive to ambient temperature. However, lower temperature TL (>200 ˚C to <300 ˚C) or shallower traps are sensitive enough for surface temperature fluctuations. The influence of temperature and climate upon the natural equilibrium TL has been demonstrated and exploited to estimate past climate of rock surface (Ronca, 1964; Ronca and Zeller, 1965). Although the feasibilities of these studies were successfully demonstrated, application was restricted due to a lack of appropriate theoretical model and numerical inverse modeling. Recent understanding of thermal influence on trapped charge kinetics and advance inverse modeling (Biswas et al., 2018) rekindled our interest to reinvestigate the application of TL as paleo-thermometry.

The present study explores the variation of equilibrium natural TL of multiple thermometers (10 TL signals between 200 and 300 ˚C) for different oscillating thermal field using forward modeling. It has been observed that the pattern of equilibrium natural TL of multiple TL signals is unique for different oscillating field. Results from synthetic experiments show that this multi thermometer approach can predict past temperature for simple periodic oscillation using inverse modeling. This is promising to predict major driving cyclicity, mean temperature and amplitude of oscillation of past temperature. To constrain the past temperature, particularly during glacial interglacial cycles, more accurately, several samples with known exposure ages (recent to 25 ka) from Mont Blanc massif have been analyzed and the results will be presented.

Biswas, R.H., Herman, F., King, G.E., Braun, J., 2018. Earth and Planetary Science Letters 495, 56-68.

Ronca, L.B., 1964. American Journal of Science 262, 767-781.

Ronca, L.B., Zeller, E.J., 1965. American Journal of Science 263, 416-428.