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Temperature thresholds for Mineral Magnetism and Thermal Activation Characteristics and their implications for reconstructing fire events

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Mineral Magnetism (MM) and Thermal Activation Characteristics (TAC) are two soil or sediment properties that become enhanced when specific temperature thresholds are reached. Both have the potential to facilitate reconstruction of past fire events and their severity.

The temperature thresholds required for changes to magnetic minerals are determined by the Curie Point(s) (CP) of dominant minerals within a sample. During a fire, when soil temperature (T) exceeds the CP, ferromagnetic minerals are formed, creating a chemical remanent magnetisation (CRM), which is retained by the heated grains. Changes to common minerals within the soil occur at T between 220-270 ˚C (Lepidocrocite) or around T $>$ 570 ˚C (magnetite). Lower temperature thresholds have been investigated for changes in thermoluminesece (TL) sensitivities of quartz grains, which increase following heating. Measurement of TAC is conducted by monitoring an electron trap at around 110 ˚C, where TL sensitivity (light output of quartz grains) experiences a peak after application of a small dose of beta radiation when the sample is subsequently heated.

In this study, we examine the changes in MM and TAC under controlled laboratory conditions for a series of temperatures and heating durations on a quartz-rich soil material from NSW, Australia that has not been affected by wildfire for $>$ 30 years.

The MM results identified that the soil assemblage was retaining a fire-enhanced sig-

nature from previous fire events of temperatures > 400 ˚C. This was established by measuring MM susceptibility changes during heating and cooling cycles. Results from the TAC experiments on the same sample confirmed the retention of a fire-enhanced signal. Variability of the thermal histories of the sample was conducted by comparison of TAC results from multi-grained aliquots (500 grains) with single grains. Preliminary results suggested that different grains within the sample had been heated to temperatures ranging between 400 - 800 ˚C.

The findings from this work highlight potential problems when using MM or TAC to detect recently burnt material, due to the retention of fire-enhanced signal. However, this work has also highlighted the opportunity for using temperature thresholds of both MM and TAC to potentially enable the reconstruction of variations in fire severity over geological time.