Heated Up: Assessment of Historic and Recent Wildfire Intensities on the Kaibab Plateau, Arizona, USA

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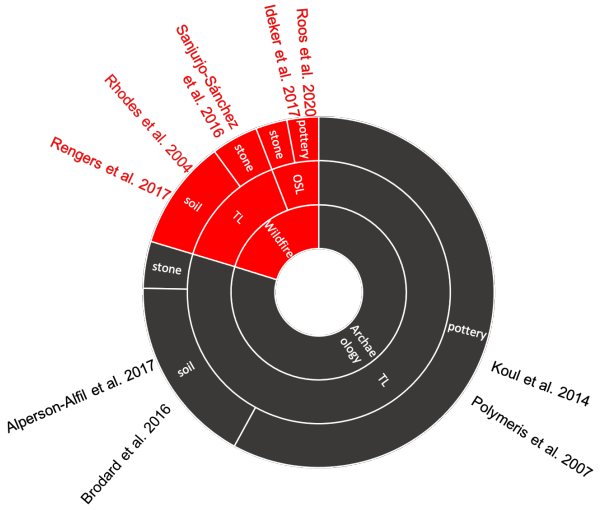
Introduction

Can luminescence methods determine surface wildfire intensity?

Limited previous luminescence-based methods assessed relative and absolute temperature of past fire exposure. Most previous research has focused on archaeological settings, with only a few studies applying these methods to understand wildfires. This study builds upon previous research to create a comprehensive and reliable method to estimate wildfire intensity using luminescence.

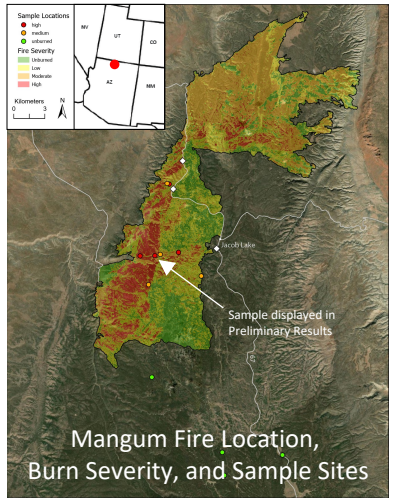
Areas Assessed by Previous Luminescence Intensity Research



Significance

The recent fire-regime shift to extreme wildfire events is currently characterized by changes in fire severity and size. While burn severity refers to ecological damage, intensity directly assesses fire heat (temperature and duration). Characterizations of wildfire intensity over the past few centuries would provide an additional metric to understand the fire regime shift, equipping land managers to make wise decisions.

Methods



Mangum Fire Location, Burn Severity, and Sample Sites

Case study: comparing luminescence temperature estimates from different soil burn severities of the 2020 Mangum Fire on the Kaibab Plateau, AZ.

Sampling Burned Soil

Surface rocks and soil core samples from different soil burn severities are assessed using two luminescence techniques.

1) OSL Resetting

Fire resets OSL apparent ages of surface rocks heated >500 ˚C.

2) Thermal Sensitivity Change

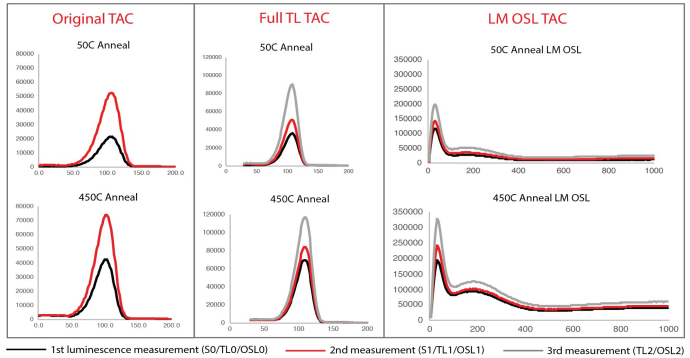
The thermal activation characteristics (TAC) ratio, the thermoluminescence sensitivity change caused by increasing sample heating, spikes at the past fire temperature.

Three Variant Protocols to Determine Thermal Sensitivity Change

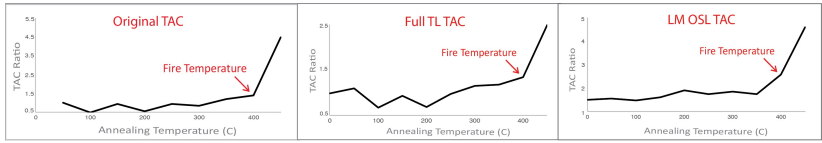
1. Original TAC Göksu et al. 1989			**2. Full pre-dose TL TAC** Polymeris et al. 2007			**3. LM OSL TAC** Sajurjo-Sanchez et al. 2018		
step	data	procedure	step	data	procedure	step	data	procedure
1		Anneal for 1 hr (3600 s)	1		Anneal for 1 hr (3600 s)	1		Anneal for 1 hr (3600 s)
2		Test dose	2		Test dose	2		Test dose
3	S0	TL up to 160C	3	TL0	TL up to 450C	3	OSL_0	LM_OSL
4		25 Gy beta dose	4		Test dose	4		TL up to 450C
5		TL up to 450C	5	TL1	TL up to 450C	5		Test dose
6		Test dose	6		25 Gy beta dose	6	OSL_1	LM_OSL
7	S1	TL up to 160C	7		TL up to 450C	7		25 Gy beta dose
8		dose	8		Test dose	8		TL up to 450C
9		PH	9	TL2	TL up to 450C	9		Test dose
10		IR check	10		dose	10	OSL_2	LM_OSL
			11		PH	11		LM_OSL
			12		IR check			
TAC = SI/S0			TAC=TL2/TL0			TAC=OSL_2/OSL_0		

Preliminary Results

Luminescence sensitivity changes with annealing temperature.



The ratio of the change in sensitivity vs. the annealing temperature estimates a fire temperature 400-450 ˚C for all three methods.



Next Steps

1. Measure TAC for samples from different burn intensity regions
2. Conduct a controlled heating test of TAC techniques
3. Test for OSL resetting of rocks within burn areas
4. Compare results with intensity estimates generated from thermally altered rock color and charcoal reflectance data

Key References
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