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Using remotely-sensed multispectral imagery to build age models for alluvial fan surfaces

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Accurate exposure age models are essential for much geomorphological field research, and generally depend on laboratory analyses such as radiocarbon, cosmogenic nuclide, or luminescence techniques. These approaches continue to revolutionise geomorphology, however they cannot be deployed remotely or in situ in the field. Therefore other methods are still needed for producing preliminary age models, performing relative dating of surfaces, or selecting sampling sites for the laboratory analyses above. With the widespread availability of detailed multispectral imagery, a promising approach is to use remotely-sensed data to discriminate surfaces with different ages. Here, we use new Landsat 8 Operational Land Imager (OLI) multispectral imagery to characterise the reflectance of 35 alluvial fan surfaces in the semi-arid Owens Valley, California. Alluvial fans are useful landforms to date, as they are widely used to study the effects of tectonics, climate and sediment transport processes on source-to-sink sedimentation. Our target fan surfaces have all been mapped in detail in the field, and have well-constrained exposure ages ranging from modern to $\sim$ 125 ka measured using a high density of 10Be cosmogenic nuclide samples. Despite all having similar granitic compositions, the spectral properties of these surfaces vary systematically with their exposure ages. Older surfaces demonstrate a predictable shift in reflectance across the visible and short-wave infrared spectrum. Simple calculations, such as the brightness ratios of different wavelengths, generate sensitive power law relationships with exposure age that depend on post-depositional alteration processes affecting these surfaces. We investigate what these processes might be in this dryland location, and evaluate the potential for using remotely-sensed multispectral imagery for developing surface age models. The ability to remotely sense relative exposure ages has useful implications for preliminary mapping, selecting sampling sites for laboratory-based exposure age techniques, and correlating existing age constraints to un-sampled surfaces.