Quantifying alluvial fan sensitivity to climate using spatial and temporal changes in grain size
BSG funded field season to Death Valley, California 2016

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Background

How fluvial sediment transport processes are transmitted to the sedimentary record remains a complex problem for the interpretation of fluvial stratigraphy. Alluvial fans represent the condensed sedimentary archive of upstream fluvial processes, controlled by the interplay between tectonics and climate over time, infused with the complex signal of internal autogenic processes. With high sedimentation rates and near complete preservation, alluvial fans present a unique opportunity to tackle the problem of landscape sensitivity to external boundary conditions such as climate.

With the generous award of **£750** granted by BSG, I was able to conduct a highly productive field season to Death Valley, California to collect valuable grain size data to add to our extensive database of a total of 11 surveyed alluvial fans.

After an initial field season in 2015 we found that grain size changes through time were both measurable and statistically significant on alluvial fans, with 30-50% coarser material being produced during the Late-Pleistocene compared to the Holocene. This pattern was observed on three separate alluvial fans, one of which crossed an entirely separate fault and each with a distinct lithology. These findings motivated the proposal for a second field season to Death Valley, specifically targeting fans with absolute dated surfaces from published OSL and cosmogenic nuclide studies. These fans would be found in the northernmost and southernmost extremities of Death Valley with lengths that were greater than 2km.

Field Work

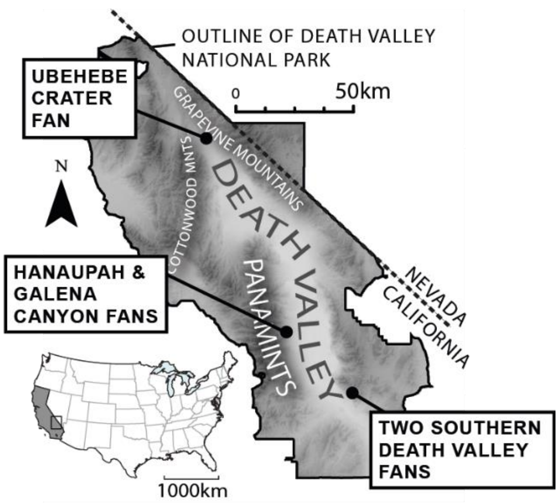


Figure 1 - Death Valley National Park with fan locations

Securing funds from BSG enabled me to conduct a 3 week field campaign to Death Valley during November 2016 where we completed 15 new grain size transects of 5 alluvial fans. **Figure 1** shows the outline of Death Valley national park and the approximate locations of the studied fans; the Ubehebe Crater in the north, the Hanaupah and Galena canyon fans on the eastern flank of the Panamint Range and two OSL-dated fans in the south of Death Valley (Sohn et al., 2007). Each fan transect was produced by counting the diameter of 100 clasts manually using the Wolman point count methodology (Wolman, 1954). In doing so, we captured the local grain size distribution on the fan surface at approximately 100-200m intervals from fan apex to fan toe.

Our field surveys enabled us to ground-truth preliminary mapping attempts conducted using remote sensing to produce high-quality geomorphic maps. In addition, we were able to specifically measure important metrics such as hydraulic geometries and fan terrace heights using a TruPulse™ 200X laser rangefinder.

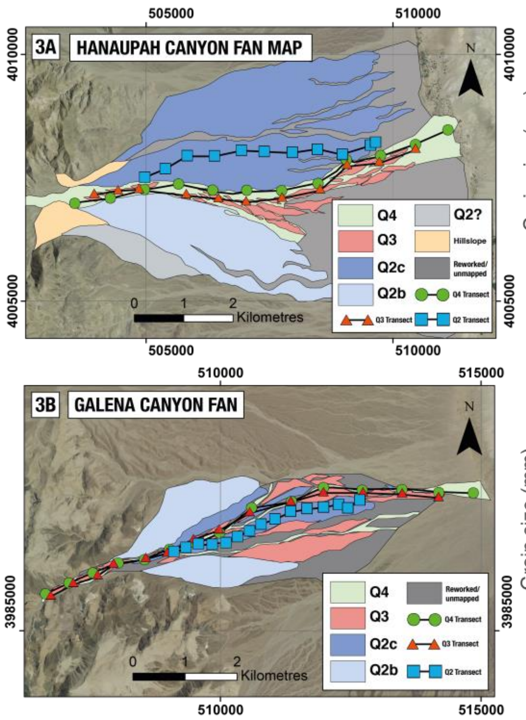
The field campaign was a success and we now have the most comprehensive database of downstream alluvial fan grain sizes ever collected. We are now in a position to establish whether the same patterns we observed in 2015 are common to Death Valley as a regional trend – a signal we could attribute to Late-Pleistocene-Holocene climatic change.

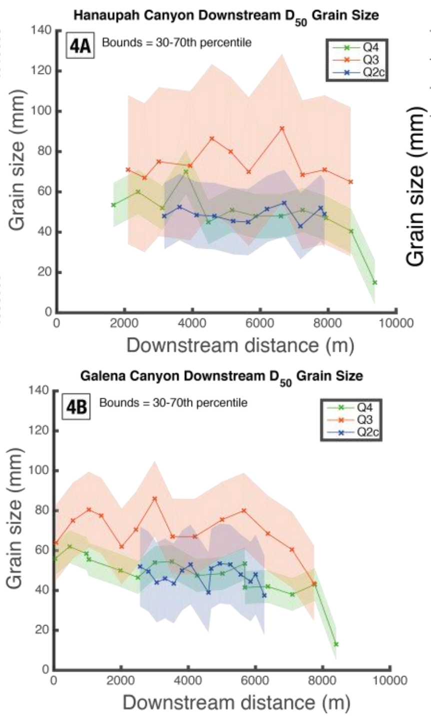
Figure 1 - Field photographs, Death Valley

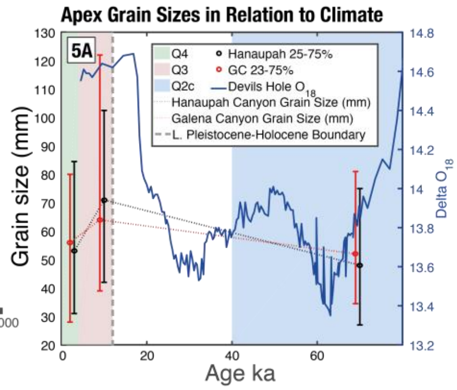
Preliminary Results & Future Work

At present we have processed the largest alluvial fans in the dataset, the Hanaupah and Galena Canyon fans that both drain eastern catchments of the Panamint Range with lengths in excess of 7km. These fans have a spatially extensive ~70ka Late-Pleistocene surface constrained using ^{10}Be cosmogenic nuclide analysis (Machette et al. 2008). We made transects down this Late-Pleistocene surface (Q2c) as well as the active channel (Q4) and a moderately varnished mid-to-late Holocene surface (Q3) that is most exposed as large islands within what is now the active channel (**Figures 3A, 3B**). Our grain size transects show remarkable similarity when we compare the grain size and fining trends in the active Q4 and Pleistocene Q2c surfaces. These are in stark contrast with the consistently coarser Q3 surfaces that also show a higher degree of grain size variance (**Figures 4A, 4B**).

We must attempt to reconcile these recent findings with respect to our age-correlated 2015 dataset and test whether there is a climatic control on the pulse in coarser grain sizes deposited during the Q3 interval (**Figure 5a**). We will process the remaining 3 alluvial fans from the 2016 campaign to establish any further grain size correlations before we conduct a suite of landscape evolution modelling approaches to explore how sensitive the landscape is to glacial-interglacial magnitude climatic change.







Figures 3A, 3B, Fan maps with grain size transects. **Figures 4A, 4B**, Downstream D_{50} (median) grain size from manual Wolman point counts. **Figure 5A**, Grain size change at fan apex through time[4], showing a peak in grain size during the late Pleistocene early Holocene or 3b surface for both fans.

References

1. Sohn, M. F., Mahan, S. A., Knott, J. R., and Bowman, D. D. (2007). Luminescence ages for alluvial-fan deposits in Southern Death Valley: Implications for climate-driven sedimentation along a tectonically active mountain front. Quaternary International, 166:49–60
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