SINGLE GRAIN OSL DATING OF MIAM QANAT SYSTEM IN NE IRAN AND SLIP RATE DETERMINATION OF DASHTEBAYAZE FAULT

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The qanat (also referred to as karez in Iran and other names in other countries) is a sustainable system of underground irrigation channels which use gravity in order to tap water in highlands from beneath the water table at its upper end and continuously distribute it through gently sloping tunnels often several kilometers long, to a ground surface outlet at tunnel lower end where it is needed for irrigation and domestic use. Along the length of the qanat tunnel, a series of vertical shafts were used for excavation of the tunnel at intervals of 10 to 140 meters to remove excavated material and to provide air circulation, lighting and access for maintenance. It can be marked on aerial photos by a line of circular craters.

In Iran many of qanat galleries were dug in the vicinity of, or directly upon, active faults. In some areas such as Dashtebayze fault, line of craters are displaced by the activity of the fault, which lead to dry qanat stream, and consequently to dig new shafts by habitants. By means of measuring the offset between new shafts and old shafts, and considering qanat antiquity, the estimation of fault slip-rate - which is one of the prominent elements in hazard assessment - becomes possible.

However, the direct dating of qanats has been problematic as no suitable method for determining the timing of construction and maintenance has yet been suggested. We provide the first direct age of an ancient qanat system through optically-stimulated dating of sediment grains within the circular spoil heaps. This method can also be used for dating wells and handmade ditches and canals.

Therefore, initially, we performed standard single-aliquot dating of the 90-150 μm quartz fractions of samples Gh1 and Gh2, and potassium feldspar of sample GH3 using standard protocols as outlined in (Fattahi et al., 2011). This provided the minimum ages of 15.8 ± 1.6ka and 22.1 ± 2.7ka for Gh1 and Gh2, respectively and average age of 9 ±1*ka* using Central age model for Gh3.

The age sequence of the single-aliquot analyses is stratigraphically inverted, with the younger age obtained from the deeper stratigraphic layer sampled (GH3), and the maintenance (GH1) yielding older age. The age inversion is not unexpected. Material removed from underground during the construction or maintenance of the tunnel, and spread around the shaft to form the circular spoil heaps (upcast), will have had only brief exposure to sunlight and so many of the grains will have had little, or no, bleaching. Standard single-aliquot methods provide the luminescence response of large numbers of grains, with many retaining significant inherited signal. Even when the minimum age model is applied, the single aliquot ages are still an average signal of many grains ranging from unbleached to fully bleached grains. If the number of fully bleached grain is limited, it then greatly overestimates the true probable age.

Therefore, we performed single-grain analyses, with subsequent statistical analysis of the equivalent dose (De) distributions to help identify the true deposition age. The age model decision processes suggested us to use of either minimum age model (MAM) or finite mixture model (FMM) for samples Gh1, Gh2, and CAM for GH3. The result for Gh1 is shown in Figure 1.

Our OSL dating thus gives the ages of last maintenance of these wells at 2.3 ± 0.3 and 1.9 ± 0.3 (overlap at ~2 ka), suggesting it was in use until 1600-2600 years ago. Combination of this age and the 10 meter Displacement of Qanat line of shafts by dashtebayaze fault provides a slip rate of 4-6 mm/yr for this fault.

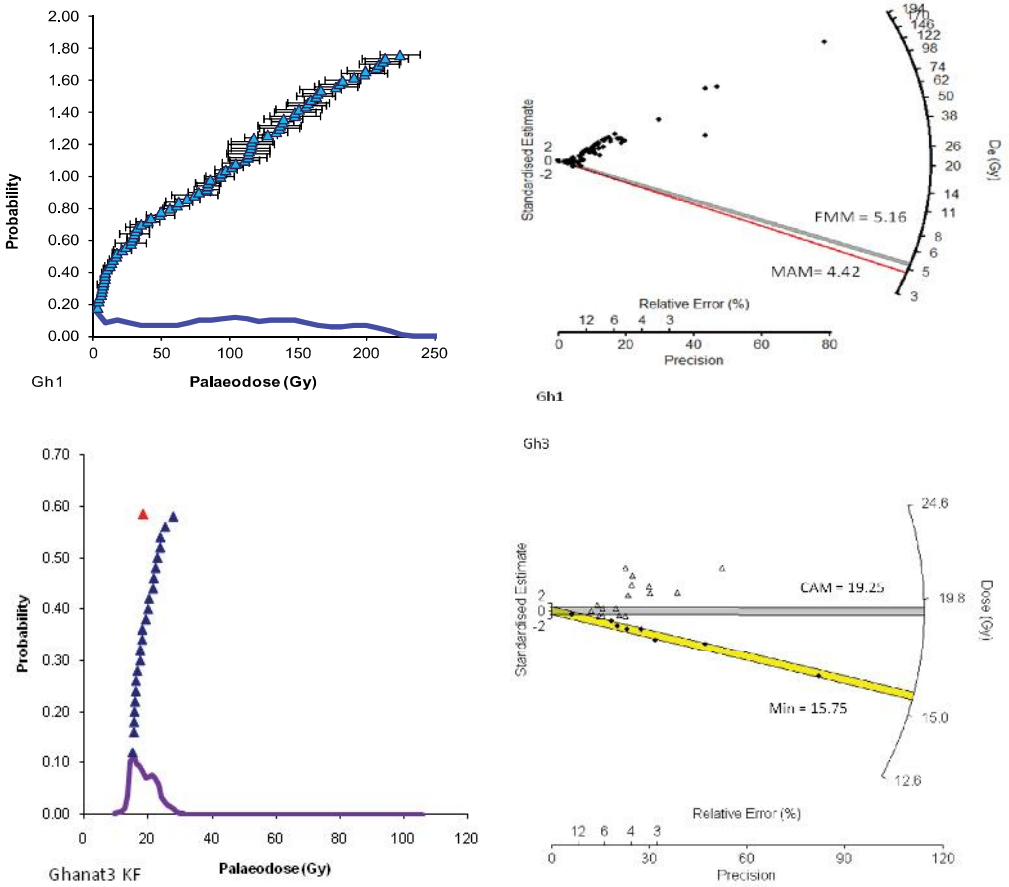

Figure 1. The De value of samples from paleosoil, representative probability and radial plots of 'mixed and scattered' large single-aliquot De distributions of samples Gh1 and Gh3. The grey bands shows values of 2 standard deviations from the De CAM estimates cantered on the reference value. The solid yellow line shows the Minimum De to compare

REFERENCES

Fattahi M, Aqazadeh A, Walker RT, Talebian M, Sloan RA and Khatib MM (2011) Investigation on the Potential of OSL for dating qanat in the Dasht-e Bayaz region of north-eastern Iran using the SAR protocol for quartz *Journal of Seismology and Earthquake Engineering*, 13(1): 65-75