CAPLTER Geology and Geophysics

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The geology and topography of the CAPLTER region provides a primary template for the spatial distribution of materials, processes operating at and near the surface, and the connectivity among those materials and processes. Given their longer time scales of study, these studies also provide important baseline process rates and event sequences. Our studies have focused on the Quaternary (last 2 million years) geologic history because of the clear record preserved on the region's piedmonts and valleys. This record is one of alternating incision and aggradation of the debris aprons surrounding the major ranges of the region, presumably modulated by incision and aggradation along the trunk drainages (Salt-Gila-Lower Colorado River systems). Detailed study areas are the White Tank Mountains and the Union Hills-Cave Creek area of north Phoenix. The western piedmont of the White Tank Mountains, located just west of the greater Phoenix area, provides a valuable natural laboratory in which we have worked to unravel this history and quantify the rates of gravel accumulation, landscape stability, and drainage downcutting. Our mapping and cosmogenic dating results indicate a period of protracted deposition from about 1.5 to 1 Ma, followed by stability and erosion, another period of accumulation at 0.8 to 0.5 Ma, and then stability and incision to the present. These results indicate that Quaternary climate change probably has the most important control on the distribution of materials and processes on piedmonts and thus establishes the physical context for ecological processes here and an approach for integrating geological and geophysical information into long-term ecological research. Along with the piedmont studies, we have undertaken a study of the subsurface geology, hydrogeology, and surface-subsurface water interactions at the Tempe Town Lake (see Fergason, et al. this volume). The construction, filling, and management of Tempe Town Lake in the alluvium-filled Salt River channel have influenced the elevation of groundwater near the lake. Since the filling of the lake in June 1999, water table elevations have been dependent upon the water retention and recovery activities associated with the lake operation. We have monitored well levels and applied detailed microgravity studies to enhance understanding of the lake operations. While groundwater elevations have not shown large variations, the relative shape of the water table has changed, which may cause a shift in flow directions. Our estimations of groundwater storage enhanced with the gravity studies provide a valuable complement and extension of City of Tempe management procedures. We find that the Tempe Town Lake affects groundwater levels out to approximately 1 km from the lake boundaries. This project is a portion of the CAPLTER studies of Tempe Town Lake that represent a microcosm of the greater CAPLTER region and have important local relevance. In addition, these studies provide background on the broader applied and societal issues concerning the

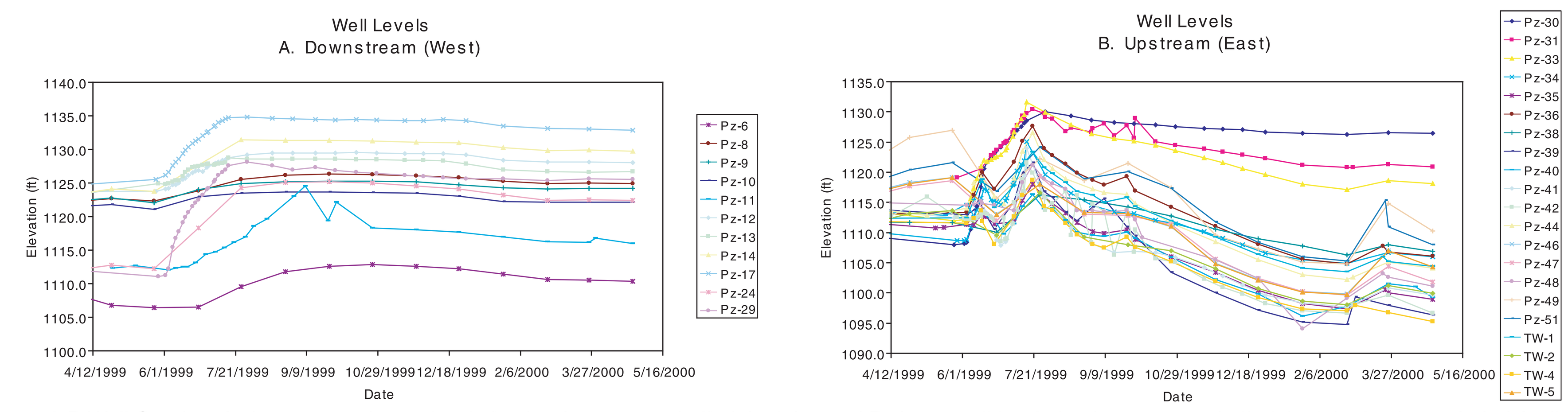
Investigation of changes in groundwater elevation associated with Tempe Town Lake

View northeast over Tempe Town Lake and the Rural Road Bridge from the top of Hayden Butte.

Well Locations. Image showing the location of wells used in this study. The solid black outline shows the location of Tempe Town Lake. The dashed lines indicate the extent of the water balance calculations of Tempe Town Lake.

North

1 Mile



2-D Well Graphs. A shows groundwater levels for the downstream half of the lake, and B shows well levels for the upstream half of the lake for the period of April 1999 through May 2000. Note that in B, Pz-30, 31, and 33 are located in the middle of the lake, and show trends that are a combination of the upstream and downstream trends. In A the lake well levels all rise after the lake fill begins and then remain fairly constant, while in B the well levels are more erratic due to recovery well activity and end at lower elevations than those at which they began. Tempe Town Lake began filling on June 2, 1999 and was full on July 14, 1999.

ACKNOWLEDGMENTS

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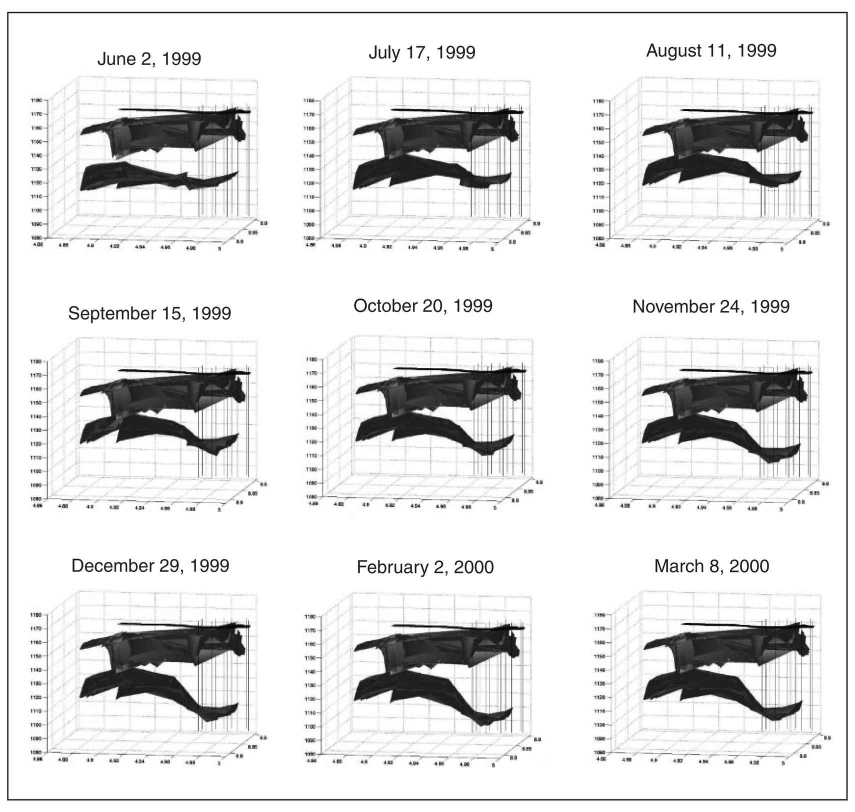
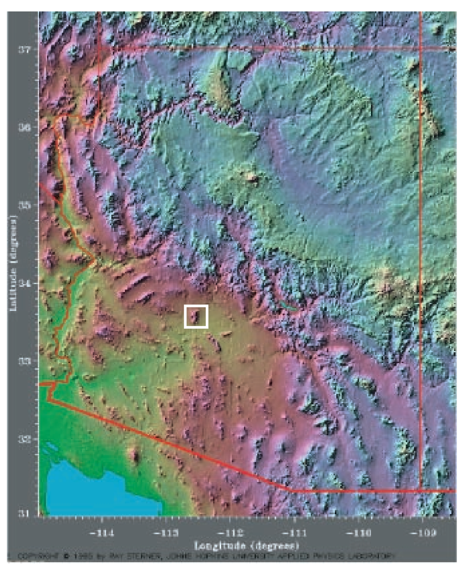


3-D Water Table Surface. These plots represent the surface of the groundwater table below Tempe Town Lake derived from well levels. The blue shape shows the approximate location of Tempe Town Lake, the upper copper surface shows crude topography, the lower copper surface shows the groundwater table, and the vertical black lines represent the recovery wells. The view is from the south of the lake to the north, with the downstream end of the lake to the left. The lake began filling on June 2, 1999 and prior to filling groundwater conditions were about the same as shown for June 2, 1999 prior to filling. The first few frames show an increase in water levels almost everywhere. Beginning around September, 1999 the water table at the east end of the lake begins to decrease significantly. This creates a water table that is has a noticeably different shape than prior to the lake fill. Note that the groundwater table surface does not take into account elevations directly under the lake.

Piedmont geology and geomorphology: processes, rates, patterns

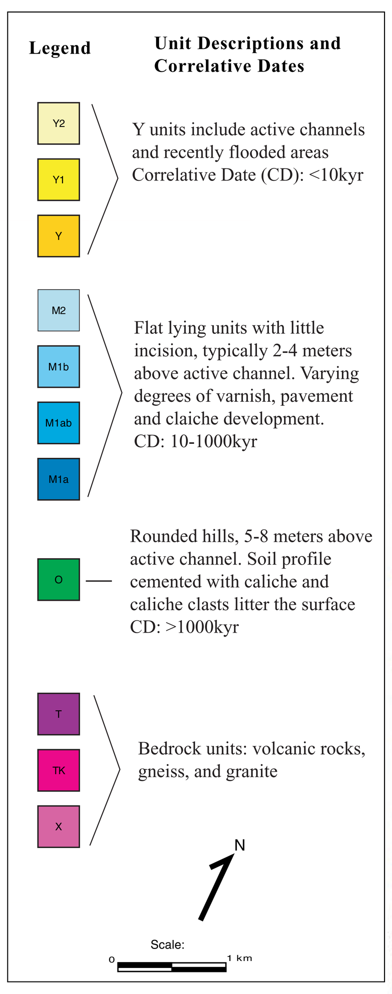


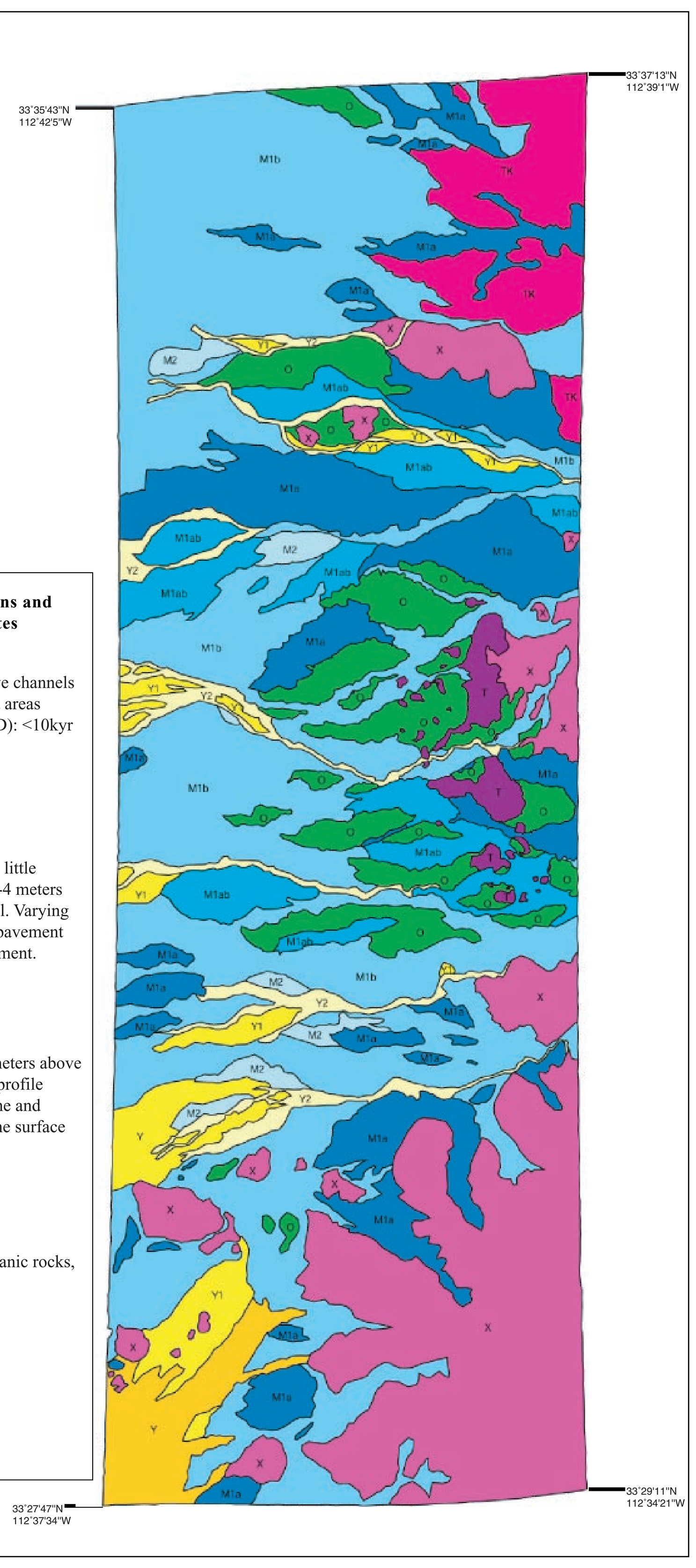
The White Tank Mountains are located in the white box seen on this digital elevation model of Arizona. Notice that the White Tank Mountains are similar to other Basin and Range mountains in that they are isolated ranges with an apron of sediment surrounding them forming a piedmont

Field Site

The study site for this project is the piedmont surrounding the White Tank Mountains. To orient you the White Tanks are in the white box on the DEM to the right and west of the Phoenix metropolis seen in the 753 Landsat image. The White Tank mountain piedmont was chose because it is a classic Basin and Range piedmont. Any techniques or information gained from studying this specific piedmont therefore can be transferred and applied to other similar piedmonts in the region. Studying the chronology and rates of process and development history of these peidmonts helps us understand a dominant part of the regional landscape.

The 753 Landsat image above shows the White Tank location west of the Phoenix metropolis. The study site is outlined in black.





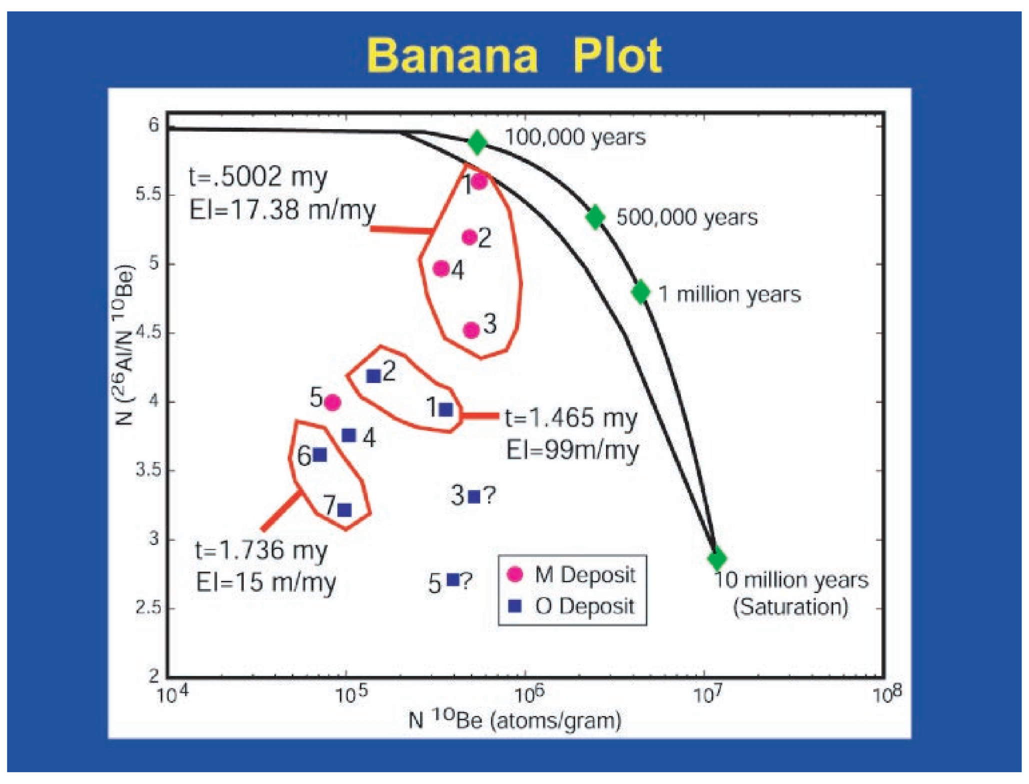
Conclusions

- Cosmogenic dating can be used in alluvial fan studies to:
  - Identify contacts between deposits of different ages
  - Provide minimum ages
  - Provide numeric ages where there are multiple samples with the same depositional history
- In the White Tank Mountain Piedmont
  - The Mid-Pleistocene surface (.5 my) is only 3- 4 meters thick and sits atop significantly older aged gravels
  - The Oldest deposit sampled is 1.5-1.7 my
- Change in Sampling strategy
  - To collect two samples at the same depth so individual sample calculations can be made

Future Research

- Statistical analysis (f-tests) to determine whether samples are part of the same depositional package based on the error change in the model and error propagation
- Evaluation of whether the older gravels under the M deposit are the same age as the O deposit

Banana Plot



Current Results

- The M deposit sampling site consists of two deposits
  - Banana plot indicates two populations
  - Minimum age for lowest sample (.775 my) is greater than age calculated for upper samples (.5002 my)
- The O deposit is dated at 1.5-1.7 my
  - It is not conclusive whether there are multiple deposits

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