FLUVIAL AND LACUSTRINE PROCESSES ON MARS AND THEIR RELEVANCE TO EXPLORING MARS’ HABITABILITY  N. Gor¹ (Contact: nisha.gor@open.ac.uk), P. Fawdon¹ and M. Balme¹. ¹The Open University, Walton hall, Milton Keynes, MK7 6AA.

Introduction: Ancient lake basins provide valuable insights about the environment of Mars [1]. These environments are important because they could also record early prebiotic processes that may have occurred in Mars’ ancient past [2, 3]. This makes such lakes ideal locations to consider the formation and/or preservation potential of physical and chemical biomarkers.

Here we investigate a chain of four coalesced craters interpreted to be a series of ancient paleolakes [4] named Abu, Varahamihira, Aarna and Kyara; henceforth the AVAK lake system (Fig. 1). The AVAK system is located in western Arabia Terra, south-east of the ExoMars Rover landing site in Oxia Planum.

The timing and persistence of this lacustrine activity, considered to have been driven by groundwater fluctuations [4], would have been governed by the regional hydrology. Consequently, studying these lakes informs us about the context of the ExoMars Rover landing site in Oxia Planum.

We present a reconstruction of the geological history of the AVAK lake system, examine its fit into the fluvial and lacustrine history of the region and consider whether it agrees or disagrees with current knowledge about Oxia Planum’s fluvial and/or lacustrine history.

Data, Methods and Approach: Geological maps of the AVAK system were created using a base mosaic of Context Camera (CTX; 6 m/pixel [5]) data enhanced with mineralogical indicators from the Colour and Stereo Surface Imaging System (CaSSiS; 4 m/pixel colour [6]) and morphological information from the High-Resolution Imaging Science Experiment (HiRISE; 0.25cm/pixel [7]). ESRI ArcPro GIS software was used to combine the imaging and other spatial data. Four High Resolution Stereo Camera (HRSC; ~10m-20m/pixel [8]) Digital Elevation Models (DEMs) were combined into one large data set and 30 CTX images were then mosaiced and draped over the DEM. The area of the four lakes (Fig. 1b) is about 30,000 km².

Key Observations: Our ongoing mapping has identified a variety of tectonic, fluvial and lacustrine processes that occurred in the study region and operated at several phases in time. These include:

Outlets: A channel flowing out from Abu crater appears to be an outlet channel that breached the rim. This shows that the water level must have reached this spillway point during one or more phases of fluvial or lake activity. Alternatively, rounded mounds at the base of outlet could be interpreted as a degraded deposit indicating flow into the crater.

Sediment Fans: Sediment fans with different morphologies are observed within each crater. They show the direction of transport between the different lakes and help constrain the depth of water in the craters when they formed. There are intercrater channels leading from Abu to Varahamihira and into Aarna from Kyara. This suggests the smaller craters Abu and Kyara filled first, then overspilled into the neighboring craters.

Interior Channels: Prominent channels around the upper parts of the crater interior walls cross-cut the sediment fans in each crater so they must be relatively recent features. They occur mainly around the north of the two large craters Varahamihira and Aarna, suggesting that the action of liquid water was ongoing for longer on south-facing slopes than north-facing ones.
**Tectonics:** Several ridge-like forms cut across the AVAK lake system. This shows that crustal shortening occurred after the lakes were active, and might provide another way to assess the minimum age of the lakes [9] and to help define the timing of their activity.

**Discussion and Future Work:** These observations show that the AVAK lake system had a complex geological history including several phases of lacustrine activity. However, these observations also highlight a number of outstanding questions about the AVAK system and its context:
- Is Abu solely an outlet lake (fig. 2a) or has there also been inflow? Also, what is the history of relative lakes levels between Kyara and Aarna (fig. 2b)?
- What volumes of water were involved with the lake systems and was this mainly groundwater flow?
- When did draining of the AVAK lake system occur? What does this mean for the timing of hydrological activity in Wester Arabia Oxia Planum relative to other processes (e.g. fig. 2d) and Oxia Planum?
- Why are later interior channels more prominent in the north wall of Varahamihira than the south?

We will continue to develop our geological map, distinguishing units using newly acquired CaSSIS data. We will also explore the AVAK lake morphometry to quantify the volume of water needed to fill craters to their outlet points. Age constraints for the exposed surfaces in AVAK will be calculated using impact crater counts, and combined with the map to give an indication of absolute timing of events in the stratigraphy. Finally, these results will be compared with ongoing studies (e.g. [10]) to consider the impact of the AVAK system on the wider Oxia Planum region.

**Conclusion:** The AVAK lake system experienced a complex fluvial/lacustrine history, including:
- Water flowed northwest out of the lake system, meaning that Abu must once have been full, and that an unknown process triggered the outflow.
- Water flowed from Kyara to Aarna, showing that there was a water level gradient between them.
- Different processes operated in different parts of the rim of Varahamihira, creating the asymmetry of interior channels seen today.


![Key observations in the AVAK lake system shown in CTX overlain with CaSSIS NPB.](image-url)