FACULTY OF SCIENCE
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DEAN (INTERIM)
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Press release **For immediate release**

HKU geologists discover that the NASA rover has been exploring surface sediments, not lake deposits for last eight years

In 2012, NASA landed the rover Curiosity in the Gale crater on Mars because the crater was thought by many scientists to be the site of an ancient lake on Mars more than 3 billion years ago. Since that time, the rover has been driving along, carrying out geological analyses with its suite of instruments for over 3,190 sols (martian days, equivalent to 3278 earth days). After analysing the data, researchers from Department of Earth Sciences, the Faculty of Science at HKU, have proposed that the sediments measured by the rover during most of the mission did not actually form in a lake.

The researcher team suggested that the large mound of sedimentary rocks explored and analysed for the last eight years actually represent sand and silt deposited as air-fall from the atmosphere and reworked by the wind. The alteration minerals formed by the interaction between water and the sand did not occur in a lake setting. The "wet" environment, they propose, actually represents weathering similar to soil formation under rainfall in an ancient atmosphere that was very different from the present one.

The discovery was published recently in *Science Advances* in a paper led by research postgraduate student Jiacheng LIU, his advisor Associate Professor Dr Joe MICHALSKI, and co-author Professor Mei Fu ZHOU, all of whom are affiliated with the Department of Earth Sciences. The researchers used chemistry measurements and x-ray diffraction (XRD) measurements, in addition to images of rock textures, to reveal how compositional trends in the rocks relate to geological processes.

"Jiacheng has demonstrated some very important chemical patterns in the rocks, which cannot be explained in the context of a lake environment," said Dr Michalski. "The key point is that some elements are mobile, or easy to dissolve in water, and some elements are immobile, or in other words, they stay in the rocks. Whether an element is mobile or immobile depends not only on the type of element but also on the properties of the fluid. Was the fluid acidic, saline, oxidising etc. Jiacheng's results show that immobile elements are correlated with each other, and strongly enriched at higher elevations in the rock profile. This points toward top-down weathering as you see in soils. Further, he shows that iron is depleted as weathering increases, which means that the atmosphere at the time was reducing on ancient Mars, not oxidising like it is on the modern day, rusted planet."

Understanding how the Martian atmosphere, and the surface environment as a whole, evolved is important for the exploration for possible life on Mars, as well as our understanding of how Earth may have changed during its early history. "Obviously, studying Mars is extremely difficult, and the integration of creative and technologically advanced methodologies are necessary. Liu and co-authors have made intriguing observations via the utilisation of remote sensing techniques to understand the chemical composition of ancient sediments that inform on their early development. Their data present challenges to existing hypotheses for both the depositional environment of these unique rock formations and the atmospheric conditions that they formed under - specifically, the authors show evidence for weathering processes under a reducing atmosphere in a subaerial environment similar to a desert, rather than formation in an aqueous lake environment. Indeed, this work will inspire new and exciting directions for future research." Assistant Professor from Department of Earth Science Dr Ryan McKenzie added.

China successfully landed its first lander, Zhurong, on Mars in May this year. Zhurong is currently roving the plains of Utopia Planitia, exploring mineralogical and chemical clues to recent climate change. China is also planning a sample return mission likely to occur at the end of this decade.

About the research team at HKU:

The Department of Earth Sciences and the Laboratory for Space Research specialise in the applications of traditional Earth and environmental science techniques and skills for modern space science challenges. Dr Joe Michalski operates the Planetary Spectroscopy and Mineralogy Laboratory at HKU, and is the Deputy Director of the Laboratory for Space Research.

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Images download and captions: https://www.scifac.hku.hk/press

Image 1. An image taken by the Curiosity Rover MastCam instrument shows layered sedimentary rocks composing Mount Sharp. The rover has been driving from the floor of Gale crater up through the rocks within these hills in order to understand how the rocks change from lower in the section (older) to higher in the section (younger). The rover have traversed rocks over >400 meters of elevation from the beginning of the mission. (Image credit: NASA's Mars Curiosity Rover)

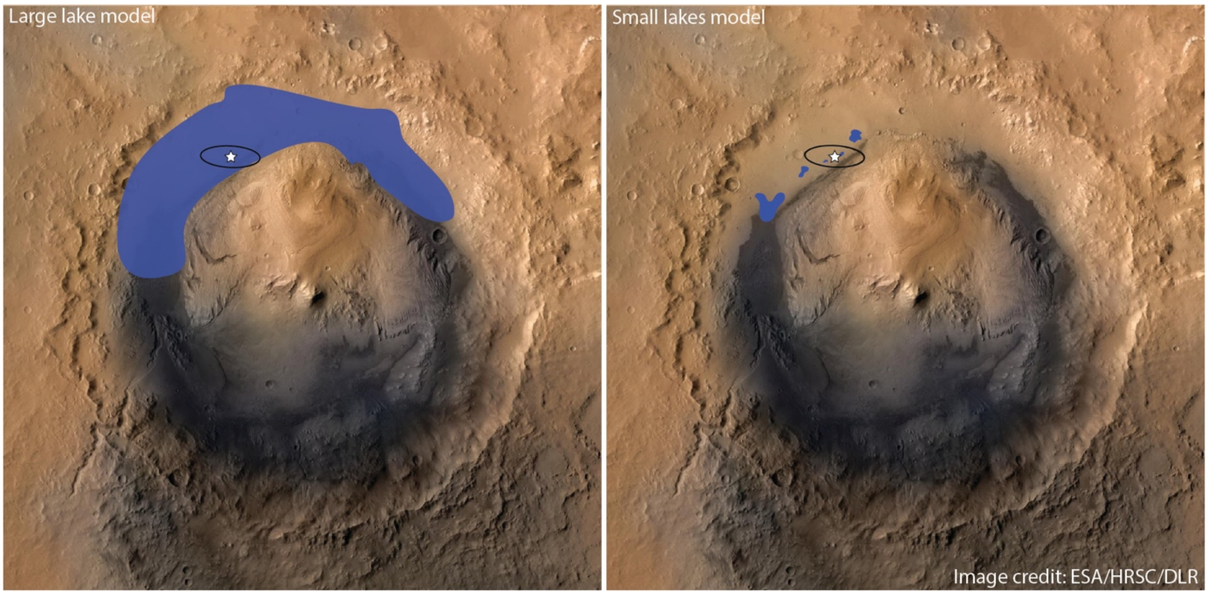

Image 2. These images show Gale crater in High Resolution Stereo Camera (HRSC) images, with elevation colorised in blue. The image on the left shows the standard model where Gale crater is generally assumed to have been a large lake (flooded to at least an elevation of ~4,000m). The image at the right is the model proposed by Liu et al., in which only very small, shallow lakes existed on the floor of Gale crater (with the crater flooded only to an elevation of approximately ~4,500m). Most the sediments were deposited from the atmosphere as air-fall deposits and later weathered from precipitation or ice-melt. A star marks the rover's landing site. (Image credit: ESA/HRSC/DLR)