JANUS
THE NEWSLETTER OF EWELL ASTRONOMICAL SOCIETY

July 2025

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Important Reminder:

To allow sufficient time to compile Janus and place it on the EAS Website by the 1st of the month any submissions for publication are required at least 3 days before the end of the month. Any items received after this date will be held over until the following month.

Editorial

Welcome to the July edition of Janus. So, half the year is gone, the Summer Solstice has passed, and longer nights are (slowly) beckoning. The past few weeks of gloriously warm evenings have, sadly, not been as welcome as they might have been for planetary viewing…… but they've been OK for deep space viewing, and great for BBQs. Whether they'll last until our annual picnic remains to be seen!

This month's talk, to be given by Prof. Adam Amara from UCL), is about "Dark Energy Surveys". There will also be the usual presentation on the "Sky at Night" for the forthcoming month.

This month's edition of Janus runs to a full 20 pages, making it one of the longest I can recall producing. It includes 6 excellent pages from John Pillar discussing Mars geology, and an article from one of our committee members (Suzanne Fox) on her involvement in the ExoClock project - an open science initiative supporting ESA's ARIEL (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) mission. There's also an update from Martin Howe on the Nonsuch Park Solar Walk project, as well as the usual information on upcoming events and planet visibility plus, of course, Gary Walker's musings and observations. So, hopefully something for everyone!

I don't know how many people have been keeping up with the progress of the many Lunar Lander missions there have been, but all has not been well here. Whilst Japan last year became the fifth country to make a soft landing on the Moon, its latest mission ended in failure on 5 June. The Resilience lander, built by the Japanese company iSpace, was launched with Firefly Aerospace's Blue Ghost lander aboard a SpaceX Falcon 9 rocket on 15 Jan. Blue Ghost arrived at the Moon 45 days later, where it landed and operated on the lunar surface until 16 March. Resilience, developed as part of iSpace's Hakuto-R Mission 2, took a less-direct, fuel-saving trajectory toward the Moon that included a flyby on 15 Feb, and reached lunar orbit on 6 May.

Carrying six payloads, including an 11-lb. micro-rover named Tenacious, the lander was targeted to touch down at 3:17 p.m. EDT on 5 June on Mare Frigoris (Sea of Cold), a basaltic plain about 560 mi. from the Moon's north pole to begin a planned 14-day mission. It crashed on the Lunar surface because its laser range finder experienced an anomaly, causing invalid measurement of its altitude, leading to inadequate deceleration. This was the second time that iSpace had lost a lander during the landing phase. **Conclusion:** Space exploration continues to be difficult!

John

skyUpdate
What's up this month?

The Solar System July

MERCURY: begins the month visible as an evening object, having recently passed greatest elongation E. It will be difficult to see, reaching its highest point in the sky during daytime and being no higher than 3° above the horizon at dusk. Becoming more difficult to see as the month progresses, by the end of the month, having recently passed in front of the Sun at inferior solar conjunction, it will not be visible reaching its highest point in the sky during daytime and being 17° below the horizon at dusk.

VENUS: is visible throughout the month as a morning object, having recently passed greatest elongation W. It begins the month visible in the dawn sky, rising at 02:26 BST – 2 hours and 19 minutes before the Sun – and reaching an altitude of 15° above the E horizon before fading from view as dawn breaks at around 04:17. By the end of the month, still visible in the dawn sky, it will rise at 02:16 BST – 3 hours and 4 minutes before the Sun – and reach an altitude of 22° above the E horizon before fading from view as dawn breaks at around 04:56.

MARS: is currently an early evening object, now receding into evening twilight. It begins the month difficult to see, reaching its highest point in the sky during daytime and being no higher than 10° above the horizon at dusk. By the end of the month, it is even more difficult to see, reaching its highest point in the sky during daytime and being no higher than 3° above the horizon at dusk.

JUPITER: recently passed behind the Sun at solar conjunction. It begins the month very difficult to see, reaching its highest point in the sky during daytime and being on the horizon at dawn. Visibility improves as the month progresses until, by the end of the month, it is visible in the dawn sky, rising at 02:59 BST – 2 hours and 21 minutes before the Sun – and reaching an altitude of 15° above the E horizon before fading from view as dawn breaks at around 04:56.

SATURN: begins the month emerging from behind the Sun, and is visible in the dawn sky, rising at 00:35 BST and reaching an altitude of 26° above the SE horizon before fading from view as dawn breaks at around 03:43. By the end of the month, it is visible as a morning object in the dawn sky, rising at 22:37 BST and reaching an altitude of 36° above the S horizon before fading from view as dawn breaks at around 04:28.

URANUS: having recently passed behind the Sun at solar conjunction, begins the month not observable, reaching its highest point in the sky during daytime and being on or below the horizon at dawn. By the end of the month, emerging from behind the Sun, it is visible in the dawn sky, rising at 00:24 BST and reaching an altitude of 27° above the E horizon before fading from view as dawn breaks at around 03:34.

NEPTUNE: is currently emerging from behind the Sun and, throughout the month, will be difficult to see. At the beginning of the month, it will reach its highest point in the sky during daytime and be no higher than 17° above the horizon at dawn. By the end of the month, now a morning object, it is visible in the dawn sky, rising at 22:32 BST and reaching an altitude of 36° above the S horizon before fading from view as dawn breaks at around 03:34.

Notable Events:

Some observations will require a telescope, others will be visible with the naked eye. More information at: *https://in-the-sky.org*

July

1 Messier 22 is well placed
The cluster IC 4756 is well placed

2 Moon at First Quarter

3 Close approach of Mercury and M44
The Earth at aphelion
Lunar occultation of Spica

4 Conjunction of Venus and Uranus
Mercury at greatest elongation east
Neptune enters retrograde motion

5 The Moon at apogee

7 Lunar occultation of Antares

9 The Great Peacock Globular Cluster is well placed

10 The Moon at aphelion
Full Moon

13 Saturn enters retrograde motion

14 Mercury at aphelion

16 Close approach of the Moon, Saturn and Neptune
Conjunction of the Moon and Saturn

17 Messier 55 is well placed

18 Moon at Last Quarter

20 Close approach of the Moon and M45
The Moon at perigee

21 Conjunction of the Moon and Venus

22 Lunar occultation of Beta Tauri

23 Conjunction of the Moon and Jupiter

24 New Moon

25 134340 Pluto at opposition
The Moon at perihelion

28 Close approach of the Moon and Mars
Conjunction of the Moon and Mars
Piscis Austrinid meteor shower 2025

30 Southern δ-Aquariid meteor shower 2025
α-Capricornid meteor shower 2025

31 Lunar occultation of Spica

August

1 Mercury at inferior solar conjunction
Moon at First Quarter
The Moon at apogee

3 Asteroid 63 Ausonia at opposition

4 Lunar occultation of Antares

6 Conjunction of Saturn and Neptune

7 The Moon at aphelion

9 Full Moon

10 Asteroid 2 Pallas at opposition
Asteroid 89 Julia at opposition

12 Close approach of Venus and Jupiter
Close approach of the Moon, Saturn and Neptune
Conjunction of the Moon and Saturn
Perseid meteor shower 2025

14 The Moon at perigee
Messier 15 is well placed
Venus at highest altitude in morning sky

15 Messier 2 is well placed

16 Moon at Last Quarter
Close approach of the Moon and M45

18 κ-Cygnid meteor shower 2025
Lunar occultation of Beta Tauri

19 Mercury at greatest elongation west
Close approach of the Moon and Jupiter

20 Conjunction of the Moon and Venus

21 Mercury at dichotomy
Mercury at highest altitude in morning sky
Conjunction of the Moon and Mercury

23 New Moon

25 The Moon at perihelion
Asteroid 6 Hebe at opposition

26 Close approach of the Moon and Mars

27 Mercury at perihelion
Lunar occultation of Spica

29 The Moon at apogee

31 Moon at First Quarter
Lunar occultation of Antares

Collected Observations (and thoughts) – Gary Walker

Bright Flare on the Sun – Posted 1 June

Yesterday, around 4:45pm, I observed that a big sunspot area was riddled with a series of bright flares. These had disappeared before 6:10pm.

This is the same big spot that had the previously mentioned "Face" in it, but the spot had now broken into at least two large spots and a mass of tiny spots. Thus, the "Face" had broken up after a day or two!

Another misleading advert on the perception of Astronomy! – Posted 5 June

I recently watched an Aviva Car Insurance advertisement showing a man walking across a field at night and joining another man, who precede to get out and set up their telescopes. All OK so far, but then it shows a supposed view through a telescope, revealing about three fireballs exploding in the field of view.

This, of course, is totally inaccurate, as you cannot see such sights in the narrow fields of views of telescopes. Meteors are too fast, and transitory, to be seen in a telescope. Presumably, they were meant to be watching a meteor shower, but as amateur astronomers know all too well, these are one of the few astronomical events that are best seen with the naked eye, which can see much more of the sky!

Obviously, the creators of the advertisement do not really understand astronomy; I have occasionally seen people in soaps, using a big telescope to look for UFO's!

Editor's Comment: Does this really matter? The advertisement is for car insurance, not telescopes. Aviva are presumably not claiming that their insurance is especially beneficial to astronomers – it's just artistic licence – so we should accept it as such.

Gen Z interested in Astronomy – Posted 8 June

Recent media reports have said that many of Generation Z are now interested in Astronomy, and there has been an increase in the sale of binoculars and telescopes, to them. TikTok has seen a rise of 540,000 in astronomical enquiries on their platform.

Unfortunately, another report said that they are also interested in Astrology! Other reports have mentioned them having an increased interest in going to church, and also Bell ringing!

This may be a result of Generation Z feeling disconnected from the material world. They also feel a sense of wonder about the unknown. We saw a similar increase in interest in Astronomy during the Pandemic.

I saw a report in the Epsom and Surrey Comet that a former Epsom high school student has been awarded an honorary doctorate. This is Ross Hockham from UK Astronomy. Unfortunately, the article is headlined "Former Epsom student gets Astrology degree"!

This perfectly summarises the continued confusion of the media in understanding the difference between Astronomy and Astrology - in this case, the article itself is about Astronomy, so the headline is almost certainly just a mistake, but the confusion remains real. It doesn't help that the two disciplines have very similar titles, originate from the same source, and are both concerned with the stars and planets.

Whatever the reason (s), the increase in people interested in Astronomy can only be a good thing for Astronomy and astronomers of all types!

Life on the Exoplanet K2-18b in doubt – Posted 11 June

Perhaps it should come as no surprise, but doubts are already being cast upon the alleged detection of Dimethyl Sulphide and Dimethyl Disulphide on the Exoplanet K2-18b, announced in April.

Other astronomers have, so far, failed to detect these molecules on this planet. So, just like the apparent detection of Phosphine in the clouds of Venus, the validity of a revolutionary discovery is again being questioned.

The Strawberry Moon – Posted 11 June

Another "Much Ado About Nothing" event happened last night and the night before, with the "Strawberry Moon" being visible.

As is their wont, the media got a little overexcited, as this is the lowest altitude Full Moon in over 18 years, with the next one, not due until 2043. This low altitude is because the Moon has reached a "Major Lunar Standstill". This is when the Moon reaches the lowest and most extreme part of its path.

The name of this Full Moon was coined many years ago by the Indigenous American Indians, as it coincides with their strawberry season. The relevance of the name to those in the UK is possibly not the same, although some people actually (incorrectly) expect it to appear pink in colour - indeed, I have already seen images of Full Moons colourised in a pink colour!

As it remains very low in the sky, the "Moon Illusion" remains all night, with the Moon appearing larger than usual.

Despite its low altitude, I could still see it from my back garden, except where the bottom of the garden hedge was too high, or I was too far up the garden.

This Moon was mentioned on the BBC News in the Weather forecast - as some astronomical events are, if they don't even make the "and finally"... news item! It was also featured at the end of the news on the next evening, as this was the second night of the "event ". So, the "Strawberry Moon " is the new" SuperMoon ", complete with giant sized Full Moons across the media!

Astronomy 50 years ago – Posted 12 June

I bought my 60mm refractor on 8 February 1975, from Dixons, in Sutton - over 50 years ago It was a lot better than the 40X40 telescope that I had used up until then!

There was a partial Solar Eclipse on 13 May 1975, but unfortunately, it was overcast!

The news on 17 July 1975 was of the link-up of an Apollo rocket with a Soyuz one, where General Thomas Stafford and Colonel Alexei Leonov shook hands.

It was hoped that the link-up would be made when they were passing over England, and I remember my science teacher talking to our class about it. One boy said to me that he supposed that "Fanatics" like me would be watching it!

The historic handshake was expected to take place over Bognor Regis, near Sir Patrick Moore's house at Selsey, and civic dignitaries were at the ready with their binoculars. Sadly, Colonel Alexei Leonov was one and a half minutes late entering, so by the time the handshake took place, they were, instead, already over the European mainland!

The Russian triumph continued with their successful landings of two probes on the surface of Venus. Venera 9 and Venera 10 landed about 150 miles apart, in late October 1975. Both successfully managed to photograph the surface of Venus, with each showing a rocky desert. They were surprised at how much light there was. The probes had brought floodlights, but found them unnecessary, as the Russians said that the light levels were like that of Moscow on a cloudy day at noon! As the conditions on Venus are

so harsh, both probes only managed to work for about an hour, before they gave up the ghost.

A bright Nova appeared in the constellation of Cygnus at the end of August 1975, which reached the 2nd magnitude, so easily visible to the naked eye. I didn't see it as there was, of course, no Internet in those far-off days, and it caught out Sir Patrick Moore and the Sky at Night programme! This was because the programme went out on 28 August, the night before the Nova appeared!

The Royal Greenwich Observatory celebrated its 300th Anniversary (and this year, celebrates its 375th Anniversary). In 1975, it was still in operation at Herstmonceux, but the 98" Isaac Newton telescope was to finish operating there only 4 years later, and was eventually moved to La Palma, where it is still operating!

Last view of Mars – Posted 14 June

This evening, I saw Mars, making a fine conjunction with Regulas, about 2 degrees to its south. So, they appeared as a straight pair, oriented North-South.

Being as Mars was now only 5.2' arcseconds in angular size, it was not surprising that nothing, apart from the disk itself was visible. No features could be seen.

At 62X, Mars only appeared as a pinhead sized disk, but at 100X, it appeared as a clear, but tiny, disk. Only, at 222X, did Mars really appear like a planet, although, of course, it still appeared small.

I have been observing this present apparition of Mars since 3 August 2024, i.e. about 10 months, with Opposition occurring on 16 January, which was 5 months ago.

This will probably be my last observation of Mars in this apparition, as it will soon disappear into the twilight and glare of the Sun, for at least a year!

Another dearth of Planets – Posted 16 June

As Martin Howe commented during his recent “Sky at Night” presentation, we are now experiencing another dearth of Planets, as most have either gone behind the Sun, or are in the early morning sky. Only Mars, is still just about clinging on in the evening sky!

Venus and the Midsummer – Posted 22 June

I managed to observe Venus at about 11am today. It was fairly easy to find (in binoculars), as it was less than 18 degrees from a waning 15% crescent Moon.

Venus now appeared as a half phase through my telescope, although it was actually about 60% phase, so officially at a gibbous phase. Of course, it is now shrinking in angular size but growing in phase. So, it will become less interesting to view from now on!

Despite its proximity to the Moon, I could not see Venus with the naked eye!

It goes without saying, the recent weather has been really good for late night observing. Last night, I was out in my garden, in just a T shirt and, despite it being breezy, it was lovely and warm!

Astronomers take heart; Now we have passed the Summer Solstice, or The Longest Day, it means that the evenings are now drawing in, again, with longer nights from now on!

So far this year, I have yet to see any Noctilucent Clouds!

Huge Filament – Posted 23 June

Over the last few days, there has been a huge and very long Filament on the Sun, stretching across nearly the entire diameter of the Sun. It is a thick filament, as well, and has been described as about 600,000 km in length. It seemed to me to be longer than that, which just shows the

sheer scale of features on the Sun. We always tend to forget this, but the diameter of the Sun, is 864,000 miles, or 1.4 thousand km!

First reappearance of Saturn – Posted 24 June

In the early hours of today, I finally saw Saturn again. Saturn is now rising at about 1:08 am, so is gradually edging back into the sky again. I have not seen it since early January, i.e. about 5½ months ago. Frustratingly, since it has been behind the Sun, it means that we couldn't actually see when the rings went precisely edge on.

The rings are, however, still as near as dammit, edge on, appearing as thin rods of light spearing out from Saturn, on opposite sides of its disk, and I could also just see the dark line where the rings crossed in front of Saturn's disk.

The only time that I have had a good view of the Rings going edge on and disappearing, was back in 1995, 30 years ago. The next time, in about 2010, was as unfavourable as this year, with Saturn behind the Sun, at the time of ring plane passage.
As you can see, these ring plane passages occur every 15 years, whilst Saturn takes 29 years to orbit the Sun.

First Noctilucent Clouds of the "Season" – Posted 24 June

Late yesterday evening, at about 11:25pm, I saw the first Noctilucent Clouds of the "Season". They were not a particularly large display, but were fairly bright, with a few ripples within them.

The Long Filament has gone – Posted 28 June

As of yesterday, the very long filament, that has been present on the Sun since 19 June, has now moved off it, to be replaced by a huge, blocky, or brick shaped Prominence on the limb!

There have been numerous other fairly thick or long filaments on the Sun, but none of the scale of this one!

Latest Observations – Posted 30 June

Yesterday, at about 11am, I saw a huge set of Prominences, detached from the top limb of the Sun. One was a particularly long "rod", which someone has said was about 200,000 km in length!

By about 7pm, the long rod was still visible, further away from the limb, but now very dim.

Over the past week or so, sunspots have still been present, but were fairly sparse, and only of small to medium size.

Later in the evening, at about 11pm, I saw a bright, extensive, Noctilucent Cloud display, extending all the way from the NW to the NE. It consisted of long filaments and "rods". By about 11:28pm, It had sunk down and faded.

Nonsuch Park Solar System Walk - Martin Howe

With the summer solstice, or shortest night, having just passed on the night of 20/2 June, the month of July will still be lacking truly dark skies. Therefore, I will take a break from "Object of the Month" and take the opportunity this month to provide an update on the society's proposed Solar System Walk project. The objective of this initiative is to install a walking route within Nonsuch Park that allows visitors to "walk through the solar system", with engaging and informative information signs along the route.

The route will be about 1.5km long, with one end at the southern London Road car park, and the other end at the Nonsuch Park café as shown in the graphic below.

Each end of the walk would have a large A1-sized display board setting out information on the walk and there would be smaller A4-sized signs to mark out each significant object.

We have established a small working group to implement the walk, comprising of myself, Suzanne, Shirish, Peter and Srikala. We have also engaged a third-party artistic design company called Whistlestop Arts, who have already done similar projects around the region (albeit no solar system walks). We will be working closely with Whistlestop Arts, the park's Joint Management Committee (representing Sutton and Epsom & Ewell councils), and the Nonsuch Voles (a volunteer group who do a lot of work in and around the park). The working group will define the route, the locations of the information signs at scaled distances, and the information content for each sign. We also intend to have more detailed information on the internet that people can link to via a QR code.

This should prove to be a wonderful asset for the park, as well as a great way to promote our society. We will even roll our sleeves up and get involved in digging holes and installing the boards! We have been fortunate enough to obtain funding from Councillor Steven McCormick through the Surrey Country Council to pay for the project. We are hoping to have a formal launch in early autumn, and the mayor of Sutton has already expressed an interest in attending. We have also enquired about having an exhibition about the society and showcasing some of the great astronomical images taken by society members.

If anyone has any questions, then please contact me via the society's WhatsApp group.

The mystery of Mercury's missing meteorites – and how we may have finally found some

Acknowledgement: This article was written by Ben Rider-Stokes, Post Doctoral Researcher in Achondrite Meteorites, The Open University and was first published in THE CONVERSATION on 25 June 2025. It is republished in full under a Creative Commons Licence. The original article, with additional links and images can be found here: *https://theconversation.com/the-mystery-of-mercurys-missing-meteorites-and-how-we-may-have-finally-found-some-259596*

Most meteorites that have reached Earth come from the asteroid belt between Mars and Jupiter. But we have 1,000 or so meteorites that come from the Moon and Mars. This is probably a result of asteroids hitting their surfaces and ejecting material towards our planet.

It should also be physically possible for such debris to reach the Earth from Mercury, another nearby rocky body. But so far, none have been confirmed to come from there – presenting a longstanding mystery.

A new study my colleagues and I conducted has discovered two meteorites that could have a Mercurian origin. If confirmed, they would offer a rare window into Mercury's formation and evolution, potentially reshaping our understanding of the planet nearest the Sun.

Because Mercury is so close to the Sun, any space mission to retrieve a sample from there would be complex and costly. A naturally delivered fragment, therefore, may be the only practical way to study its surface directly – making such a discovery scientifically invaluable.

Observations from NASA's Messenger mission have inferred the surface composition of Mercury. This suggests the presence of minerals such as sodium-rich plagioclase (such as albite), iron-poor pyroxene (for example enstatite), iron-poor olivine (such as forsterite) and sulfide minerals such as oldhamite.

The meteorite Northwest Africa (NWA) 7325 was initially proposed as a possible fragment of Mercury. However, its mineralogy includes chromium-rich pyroxene containing approximately 1% iron. This poorly matches Mercury's estimated surface composition. As a result of this, and other factors, this link has been challenged.

Aubrite meteorites have also been proposed as potential Mercurian fragments. Recent modelling of their formation suggests an origin from a large planetary body approximately 5,000km in diameter (similar to Mercury), potentially supporting this hypothesis.

Although aubrites do not exhibit chemical or spectral (the study of how light is broken up by wavelength) similarities with Mercury's surface, it has been hypothesised that they may derive from the planet's shallow mantle (the layer beneath the surface). Despite ongoing research, the existence of a definitive meteorite from Mercury remains unproven.

Our latest study investigated the properties of two unusual meteorites, Ksar Ghilane 022 and Northwest Africa 15915. We found that the two samples appear to be related, probably originating from the same parent body. Their mineralogy and surface composition also

exhibit intriguing similarities to Mercury's crust. So, this has prompted us to speculate about a possible Mercurian origin.

Both meteorites contain olivine and pyroxene, minor albitic plagioclase and oldhamite. Such features are consistent with predictions for Mercury's surface composition. Additionally, their oxygen compositions match those of aubrites. These shared characteristics make the samples compelling candidates for being Mercurian material.

However, notable differences exist. Both meteorites contain only trace amounts of plagioclase, in contrast to Mercury's surface, which is estimated to contain over 37%. Furthermore, our study suggests that the age of the samples is about 4,528 million years old. This is significantly older than Mercury's oldest recognised surface units, which are predicted (based on crater counting) to be approximately 4,000 million years.

If these meteorites do originate from Mercury, they may represent early material that is no longer preserved in the planet's current surface geology.

Will we ever know?

To link any meteorite to a specific asteroid type, moon or planet is extremely challenging. For example, laboratory analysis of Apollo samples allowed meteorites found in desert collection expeditions to be matched with the lunar materials. Martian meteorites have been identified through similarities between the composition of gases trapped in the meteorites with measurements of the Martian atmosphere by spacecraft.

Until we visit Mercury and bring back material, it will be extremely difficult to assess a meteorite-planet link.

The Bepi-Colombo space mission, by the European and Japanese space agencies, is now in orbit around Mercury and is about to send back high-resolution data. This may help us determine the ultimate origin body for Ksar Ghilane 022 and Northwest Africa 15915.

If meteorites from Mercury were discovered, they could help resolve a variety of long-standing scientific questions. For example, they could reveal the age and evolution of Mercury's crust, its mineralogical and geochemical composition and the nature of its gases.

The origin of these samples is likely to remain a subject of continuing debate within the scientific community. Several presentations have already been scheduled for the upcoming Meteoritical Society Meeting 2025 in Australia. We look forward to future discussions that will further explore and refine our understanding of their potential origin.

For now, all we can do is make educated guesses. What do you think?

Mars Rocks!!! – John Pillar

A rich dataset of images has been collected by the Perseverance Rover in the Jezero Crater area. Cliffs and escarpments on the margin of the Jezero Crater provide a unique image of geologic features that reveal repeated cycles of sediment deposition – cyclicity driven by climate change, just like on Planet Earth.

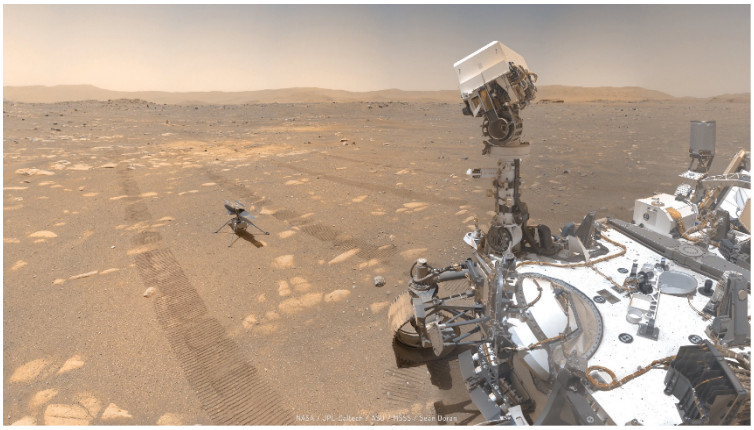


Figure 1: Perseverance and Ingenuity helicopter (Image credit NASA/JPL-Caltec/MSSS/Seán Doran.

Let's dig into the images and see what secrets we can unearth about Mars' early climate and geologic history (sorry about that 😊).

The present-day Mars is very dry - water can only exist as ice and vapour because the atmospheric pressure and the temperature are so low. The surface pressure on Mars is about 0.6% of Earth's and temperature ranges from -153 to +20C, with an average of -63C. In order for water to exist on Mars the atmospheric conditions must have been very different – so what do we know about the evolution of Mars' atmosphere?

- Atmospheric chemistry, isotopic ratios (e.g. $^{14}N/^{15}N$, deuterium/hydrogen, $C/^{84}Kr$) and studies of gas trapped in meteorites from Mars indicate that the early atmosphere was significantly denser than it is today, and therefore surface pressure was higher - estimates range as high as 4 bars.
- A dense atmosphere, believed to have been rich in CO_2, would have enabled a strong greenhouse effect and warmed the surface above the freezing point of water. Increased temperature, coupled with increased surface pressure, would have permitted the presence of liquid water.
- The familiar red colour of Mars is caused predominantly by ferrihydrite: an iron oxide (rust) that contains a water molecule ($Fe_2O_3.nH_2O$). Ferrihydrite forms in the presence of cool water and its presence on Mars is consistent with there having been liquid water on the surface.
- Between 3.8 and 4.3 Byr ago the Earth, Moon and Mars suffered an intense bombardment (the Late Heavy Bombardment LHB), recorded in the craters on the Moon and Mars. Because Mars' gravity is relatively weak, the impacts are believed to have caused significant loss of the Martian atmosphere.
- Mars lost its magnetic field about 4 billion years ago. The reason for this loss is uncertain – the LHB may have caused partial recrystallisation of the inner core and disrupted the convection that drove the magnetic field. Due to the lack of magnetic field, the solar wind and cosmic radiation impact directly on the upper atmosphere and constantly strip it away. The thin atmosphere on Mars can be partly, but not totally, attributed to the loss of magnetic field.

In summary, the evidence suggests that Mars lost its atmosphere about 3 Byr ago, and since that time has been a dry, cold planet. The sediments we see in the Jezero Crater

area were deposited before this time and subsequently eroded and exposed by 3Byr of wind (sand-blast) erosion.

The delta from above

The satellite view of the western margin of Jezero Crater shows a very typical delta (Figure 2), formed when a river enters a broad lake or sea. The western edge of the crater and the

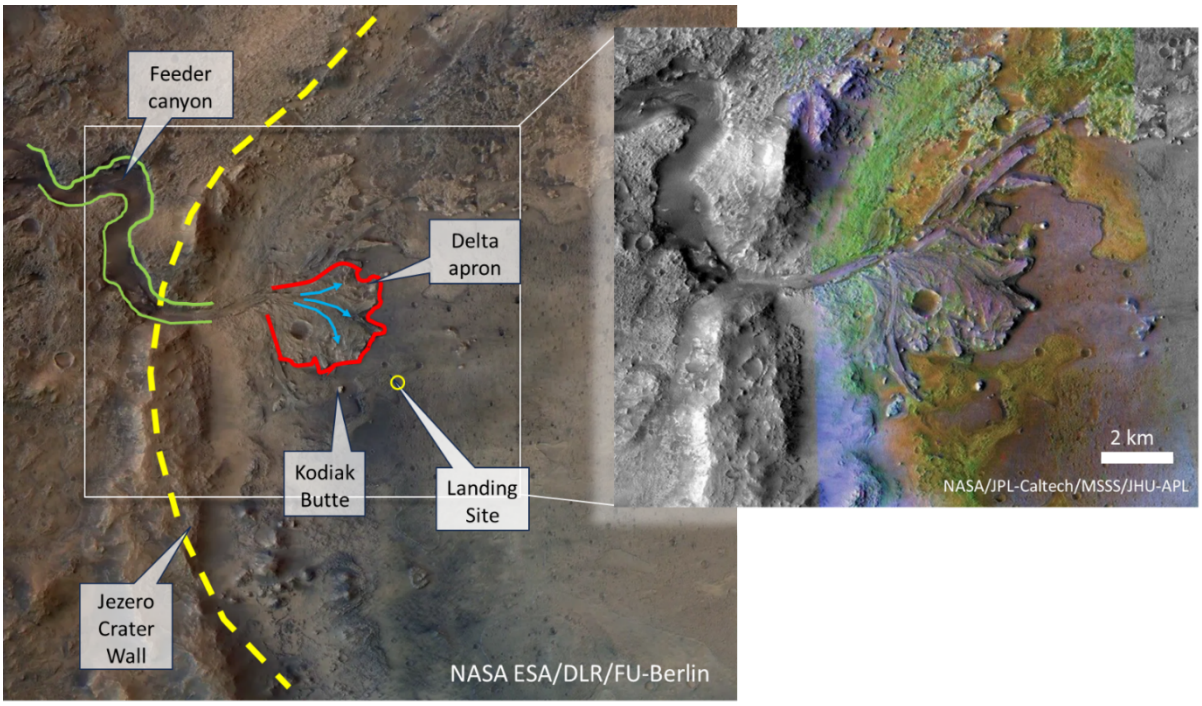


Figure 2: Satellite images of the western margin of Jezero Crater. The sediment of the delta, the confined meandering feeder channel, and flat crater floor (forming the lake bed) can be identified.

crater wall can be seen, and to the west you can see the sinuous feeder canyon that carried the water and sediment runoff toward the delta. The canyon enters the crater through a notch cut in the crater wall. The canyon is about 1km wide, and the steep canyon walls suggest that the water flow was very erosive, implying that the river was turbulent, fast flowing, and probably due to storm induced flash flooding or seasonal melting of snow or glaciers.

When a sediment laden river enters the lake, the current flow slows and sediment load falls out, depositing to form the delta as an amalgamated stack of multiple lobes.

Kodiak Butte

Some of the most informative images of the Jezero delta were taken of an isolated erosional remnant, called Kodiak Butte (location on Figure 2). The cliffs of Kodiak Butte (Figure 3) provide a cross-section through the geology, like a slice through a cake, and reveal internal depositional geometries of a delta. This summary is largely based on the Caravaca et al (2024) paper, reference is in the annotation of Figure 3.

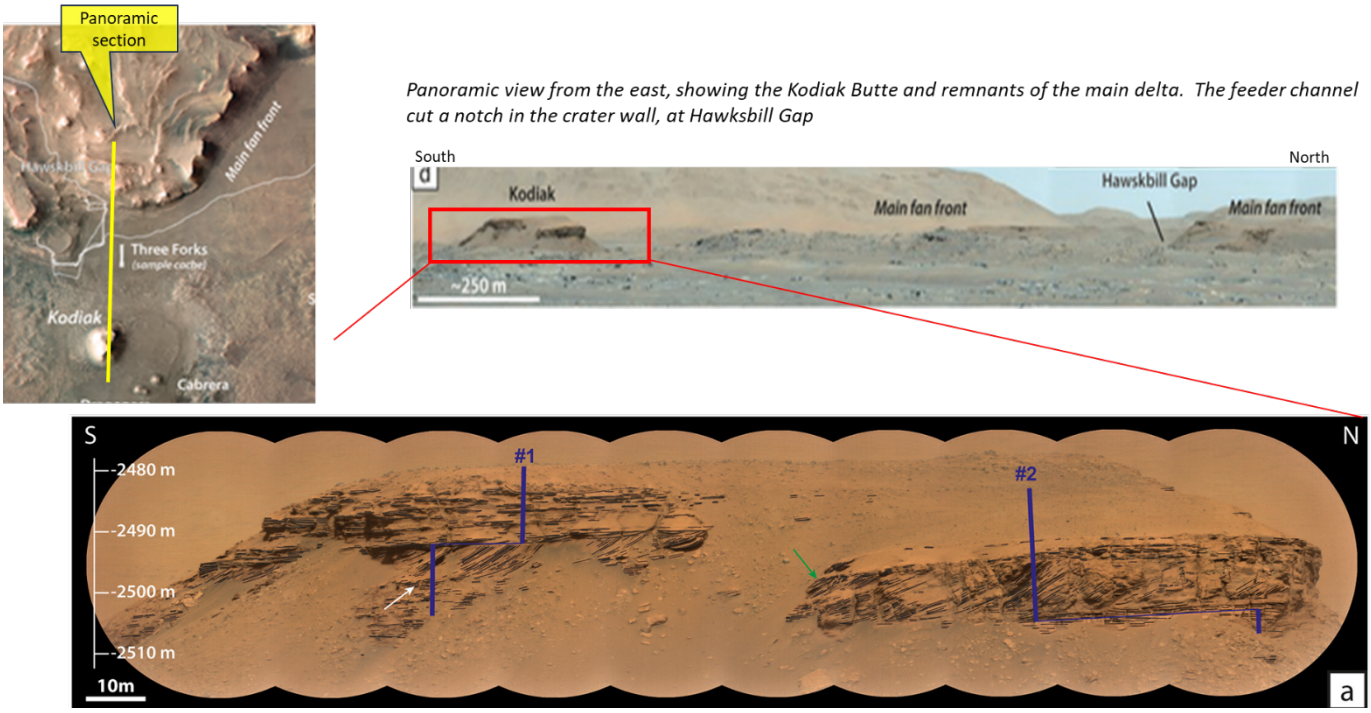


Figure 3: Panoramic view of the Kodiak Butte from a distance. The main delta fan (top right, location is shown on the map, top left) built out from the right towards the left. Below is a zoomed-in annotated image of the Kodiak Butte. From Caravaca et al (2024). Depositional Facies and Sequence Stratigraphy of the Kodiak Butte, Western Delta of Jezero Crater, Mars. Journal of Geophysical Research: Planets, 129.

A close look at the Kodiak Butte outcrop (Figure 4) shows flat lying strata at the base (1), overlain by a panel of dipping layers (2) that are abruptly cut at the top by a flat surface, above which there are more flat lying strata (3). There appears to be another bounding surface above (3) and flat, discontinuous strata (4). At the very top there is a layer of rubbly, blocky material (5) deposited on an irregular (rugose) surface shown in blue on the figure.

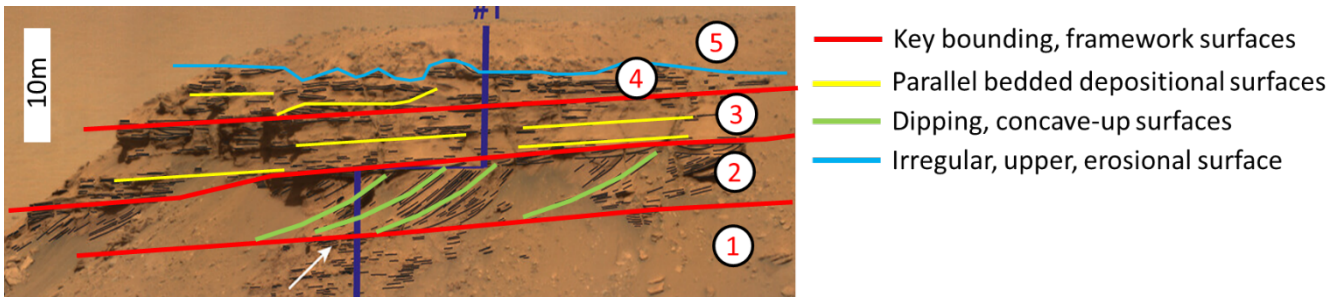


Figure 4: Zoom in detail of Kodiak Butte

Harder rocks, like sandstone, are typically eroded less by weathering and stand out, whereas muds/clays are preferentially eroded and form recessive notches in the outcrop. The Kodiak Butte outcrop shows many thin alternating layers of sand and mud.

The strata and surfaces of Kodiak Butte are the result of a fundamental interplay between water depth and sediment supply … processes well documented from planet Earth in delta systems.

How does lake level typically vary?

Water depth (lake level) in Jezero Crater will rise and fall in response to medium/long term climate change. Climatic periods when 'there is more water around', in an interglacial for example when there is no ice on the polar regions, will be characterised by increased rainfall and more fluvial runoff, and lake level will be high for long periods. Conversely, during periods when the global climate is more arid, for example during glacial periods when water is locked in ice at the poles, there will be less fluvial runoff and lake level will be low for long periods.

Climate cyclicity (and lake/sea level) typically occurs on a combination of short- and longer-term time scales – illustrated in Figure 5. Long term cycles are primarily caused by regular

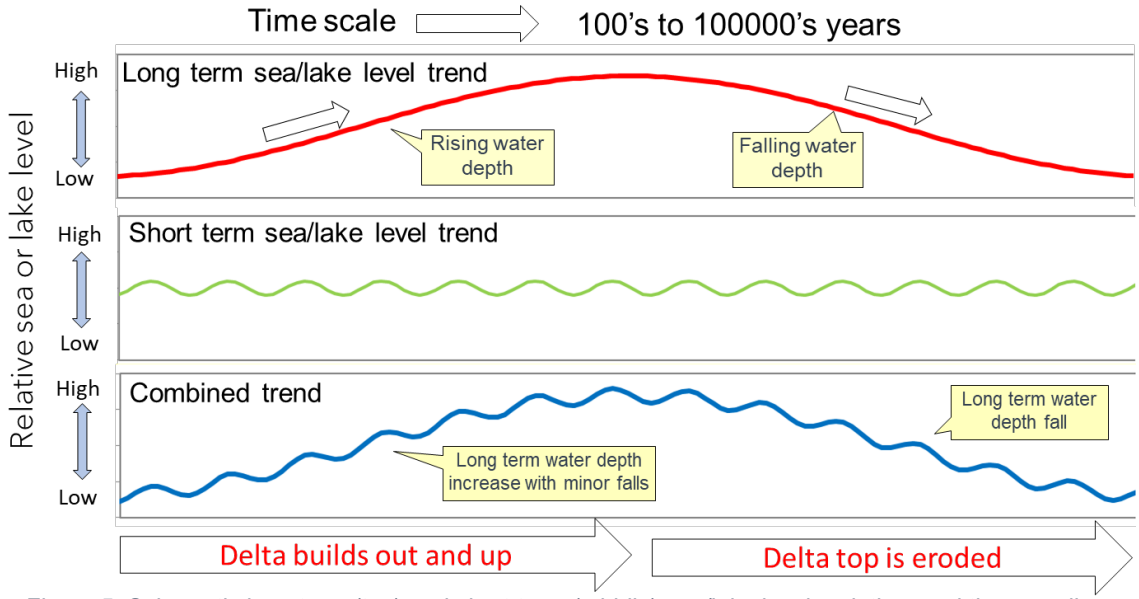


Figure 5: Schematic long term (top) and short-term (middle) sea/lake level variation, and the overall combined effect (bottom). Coastal geology on planet Earth is governed by cyclicity like this, and Kodiak Butte demonstrates cyclicity in early Mars' history

changes in a planet's orbits (Milankovitch cycles), axial tilt and solar radiation variations. Short term cycles can be influenced by volcanic eruptions, meteor impacts in the early solar system, the Martian year, cyclical changes in CO2 content of the atmosphere, and global scale dust storms.

How does lake level affect the delta?

Sediment (sands, silts, and clay particles) are delivered to the lake by the river system, and when the river flows into the standing body of water the flow slows and the sediment falls out, deposited on the lake floor. Coarse grains of sediment are deposited first (sands), then silts, and finally muds, in the deep water, resulting in a delta build-up illustrated in Figure 6.

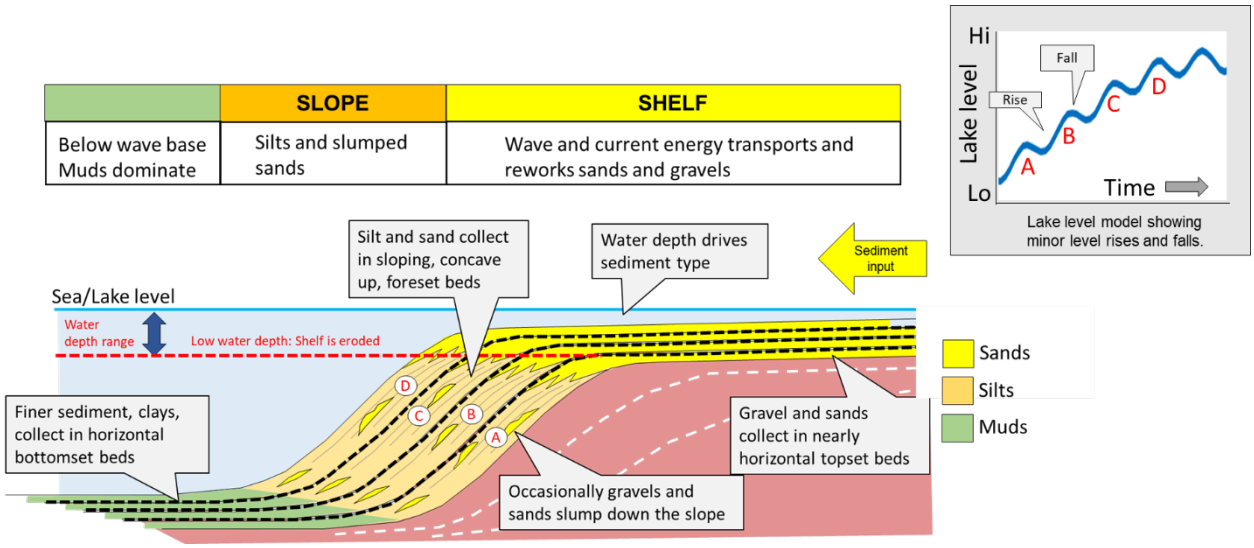


Figure 6: Schematic cross section through a delta, illustrating sediment input from the right, shallow water shelf, slope and basin floor. In general, shallow water. Each cycle (A-D) is the result of a minor cycle of lake level rise and fall. Inset on top right shows a simple model of several lake level cycles – cycle A might result in unit A on the cross section, B to B and so on. The minor lake fall after rise A is recorded in the cross-section as the bold dashed line bounding the top of unit A

During a period of rising lake level, such as cycle A for example, (4 cycles are illustrated in Figure 6, A-D), the delta builds out into the lake – sandy sediments near the shore, silts on the slope and a thin layer of mud on the lake floor. Cycle A is terminated by a minor lake fall (see the inset lake level model) and sediment buildup will stop - the delta may experience some erosion, recorded in the cross section as the bold dashed line bounding the top of cycle A. Lake rise B then follows, and the same pattern of deltaic deposition, buildup, and erosion will repeat.

Eventually the effect of the underlying long-term trend of lake level rise turns around and a major fall ensues – illustrated on the right-hand side of Figure 5. Major lake level falls can dramatically reshape the delta – not illustrated on Figure 6, but seen in the actual outcrop of Kodiak Butte in the rubbly top layer.

Kodiak Butte outcrop and climatic cycles

Kodiak Butte records 3 cycles of major lake level rise and fall, superimposed on many minor cycles. The combined impact of three major and many minor lake-level variations are recorded in the rocks of Kodiak Butte, and schematically illustrated in Figure 7. The sequence runs from bottom to top –starting with rising lake level and delta build-out, fed by fluvial input from the right. The shallow water portion is dominated by sands and gravels, the slope by silts and interbedded muds, and the lake floor by muds. When lake level falls the shallow water area is exposed to erosion (e.g. surface (1), shown in red) and a new coastal land surface is formed. This is flooded in the following major lake level rise, and the

delta builds out again over the erosion surface (1). This sequence is repeated 2 more times – each topped by an erosion surface (shown in red).

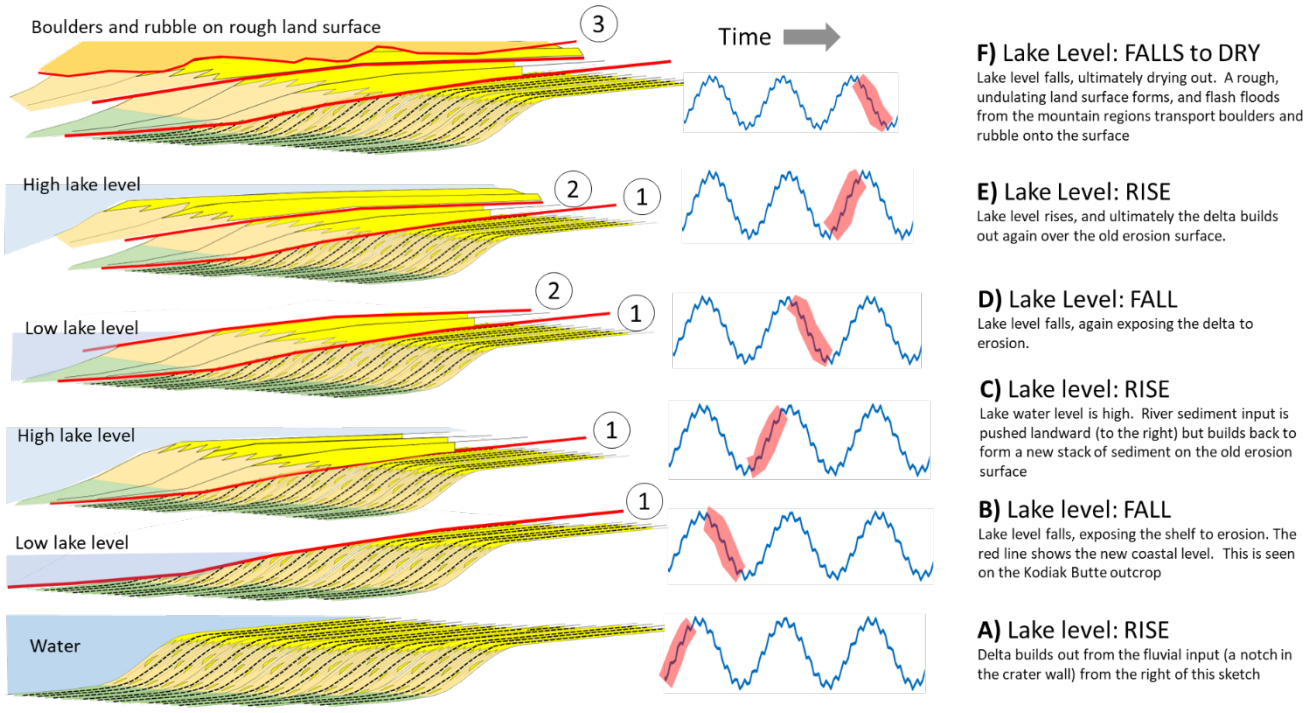


Figure 7: Kodiak Butte delta growth recorded in the rocky outcrop image. Starting with the bottom image, progressing upward. The lake-level curves are highlighted in red to show the active portion of the lake-level cycle.

The sequence illustrated in Figure 7 can be ground-truthed on the Kodiak Butte image (Figure 8), taken from the Caravaca et al (2024) paper, annotated with the bold red lines to show the key erosive surfaces recording major lake-level falls at Jezero Crater (surfaces 1, 2 and 3 in Figure 7). Three major cycles of lake level change are recorded, culminating in a

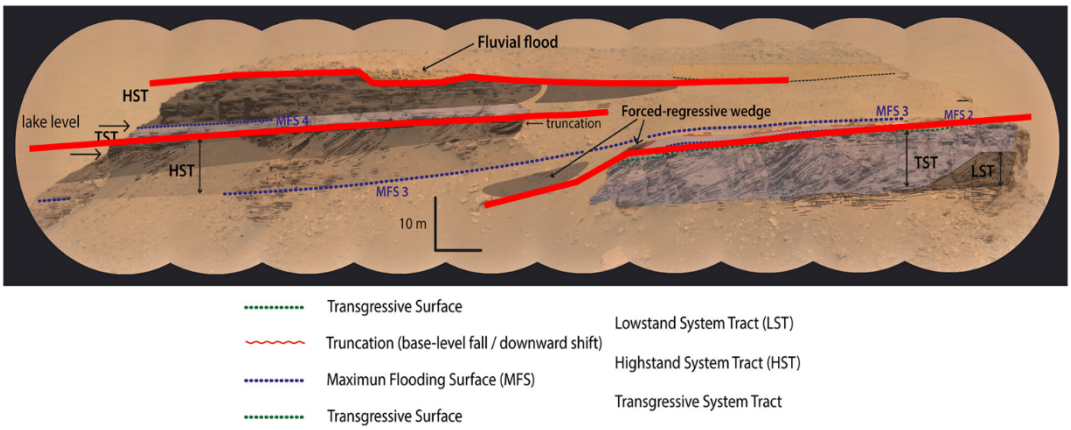


Figure 8: Annotated image of Kodiak Butte output, from Caravaca et. al., (2024). The key erosional bounding surfaces recording periods of significant lake level fall are shown in red, between which the delta prograded across the lake floor

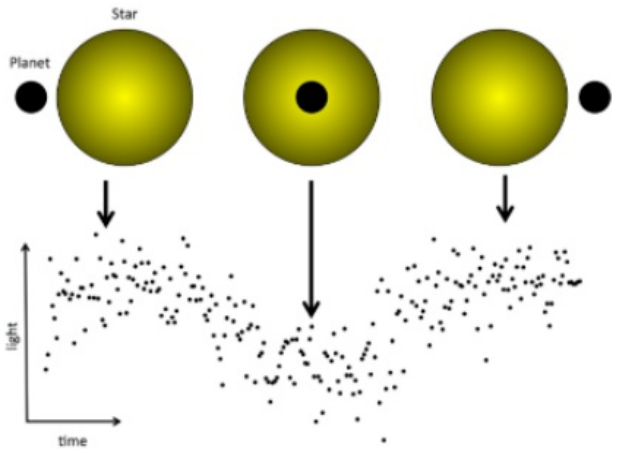
period of significant arid climate (the uppermost rubbly unit). Between the periods of erosion the delta developed across the lake floor, progressive growth recorded in the panels of dipping sand, silt and mud strata. The fluctuations in lake level are attributed to variations in water input via the river system, which are in turn related to larger-scale climatic events, probably driven primarily by astronomically driven phenomena in the early solar system.

The ExoClock project – Suzanne Fox

Background

Over the first few months of 2025 I volunteered on the ExoClock project - which is an open science initiative supporting the European Space Agency's ARIEL (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) mission - *https://arielmission.space/*.

The ARIEL space telescope is due to launch in 2029, it will study the chemistry of around 1000 planets outside our solar system, with University College London leading the mission science, and over £30m of funding from the UK Space Agency.



Source : https://www.exoclock.space/

ARIEL will collect spectroscopic data about exoplanets as they transit across the face of their sun.The light from the star dims very slightly during the transit, and the spectrum of the light passing through the atmosphere of the planet shows the chemical composition.

In order to make the most efficient use of ARIEL during its lifetime we need to have very accurate timings of the schedule of planetary transits (called ephemerides). That's where the ExoClock project comes in.

The purpose of ExoClock is to observe transits of currently known exoplanets and assess how accurate our knowledge of the transit schedule is. ExoClock rents observing time on big telescopes from the LCO network - Las Cumbres Observatory mission *https://lco.global/about/* - is a non-profit science institute comprising a worldwide network of robotic telescopes, operated by an automated scheduler.

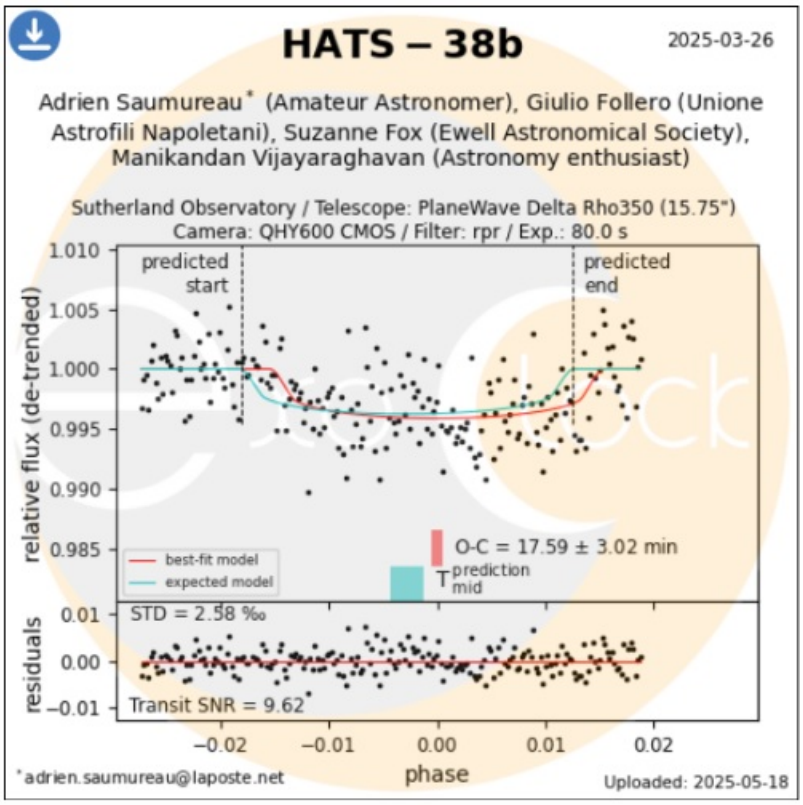
ExoClock has been running for the last few years and I volunteered in the fifth cohort. You didn't need any particular qualifications to be included, but it did cost 200 Euros which was to cover the rental of the telescope time.

There were around 30 people in my cohort, and we split into teams of 3-4 people. My teammates were really great to work with - both academics - one French and one Italian, so very international. We chose a planet more or less at random from the list the Exoclock team keeps of transiting planets which we don't have good data for. We chose HATS-38b which orbits a 12th magnitude G-type star (so similar to our Sun) in the constellation Hydra. Hydra was in the view from my back garden during the winter, which was quite exciting, although I couldn't see 12th magnitude stars.

There was a Zoom meeting every month where the ExoClock team talked us through what to do at each stage of the project. It was all very well organised. The steps we followed were:

- Choose a target from the list of known but not yet verified transiting exoplanets.
- Research the current knowledge about the planet and its sun
- Choose a target date and time of a transit to observe.
- Determine the parameters for the chosen transit observation
- Submit a request for time on a telescope, it might not be accepted
- See if the observation is successful, the weather might interfere or another request might be deemed more important
- Once the observation is complete, download the images and process them
- Run the analysis software which detects the transit, adjust the parameters and configuration to get the optimal result
- Add to the body of knowledge about the chosen planet
- Present the findings to the group

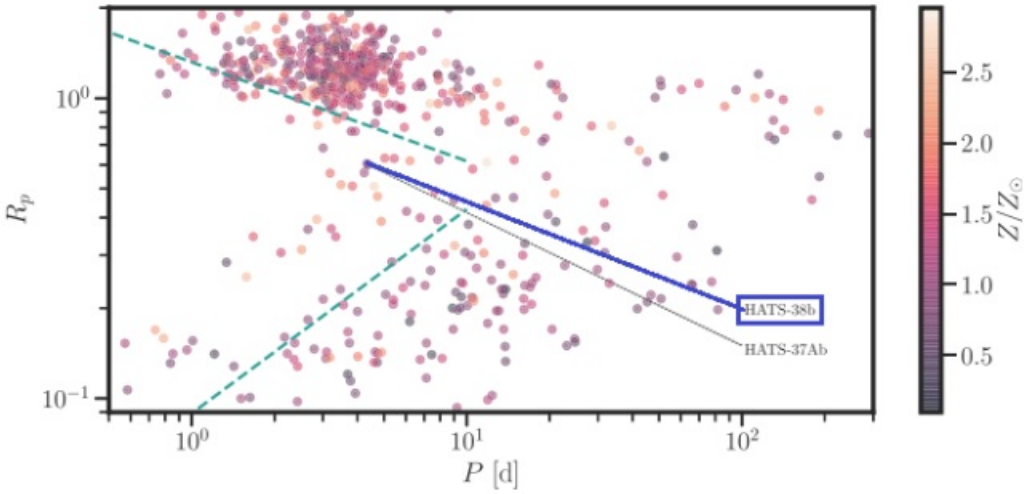
Here's the final output of my team's observation, which is now part of the ExoClock database. I made sure Ewell Astronomical Society is mentioned !



A short story about HAT-38b

It turns out HATS-38b is an unusual planet - it was discovered by the HATSouth survey in 2020. The statistics of exoplanets are given relative to Jupiter which makes it easier to compare to what we know. HATS-38b has mass about 7% of Jupiter, radius 60% of Jupiter, so it's big but not dense. The reason for that is that it orbits very close to its parent star at a distance of 0.05 AU, and it transits every 4.5 days. Unusually it is in a polar orbit, theories are that there is some very dim second body in that system or there was some catastrophic event in the formation of the system.

Its characteristics put it in a class of planets called 'Hot Neptunes' . If we plot orbital period (P) and planet radius (R) on a graph there's an area called the 'Neptune Desert' where planets like HATS-38b are rare, and there's a lot to be learned about the mechanics of planetary system formation which the academic papers touch on.



Sources : *HATS-37Ab and HATS-38b: Two Transiting Hot Neptunes in the Desert*
HATS-38 b and WASP-139 b Join a Growing Group of Hot Neptunes on Polar Orbits

What I learned

I learned a lot from this experience. The background of ARIEL and ExoClock of course, but there's nothing like hands-on experience of contributing to make you feel part of it. It was really exciting to get the images from our observation to work with - even though they were images of star fields and not of any of the amazing astronomical objects.

In order to interpret the transit images, you need to compare the target star with similar stars in the image, to do that you need to reference the large stellar catalogs such as GAIA and SIMBAD. I didn't know anything about these before but they are super interesting.

My day job is as a programmer, and I've wanted a chance to play with some of the astronomical python (programming language) libraries which they use to process images - having these observations gave me the chance to do that.

And it's nice to have taken the time to research one particular exoplanet, and hear from the other teams about the planets and systems they chose. There's so much to know.

If you have a spare 200 Euros I'd highly recommend participating, the project runs for a few more years and it will give you a real sense of involvement in astronomical research. I'm really looking forward to learning even more about HATS-38b once ARIEL launches !

Up Next:

NEXT MEETING: 8pm Friday 11 July – Nonsuch High School

Prof. Adam Amara from UCL will talk about "Dark Energy Surveys".

As usual, there will also be a presentation on the sky at night for the coming month.

NEXT USER GROUP:
Suspended until further notice.

NEXT DENBIES OBSERVING SESSION:

The next sessions, allowing for moon rise & set times and cloud conditions, should be sometime around the new moon which is on 24 July.

The precise date and timings of any session will be advised by email and WhatsApp a few days in advance but should be within the period 20 – 27 July.

AD HOC OBSERVING AT WARREN FARM:

These will be at short notice when the weather is favourable, and may replace, or be additional to, sessions at Denbies. Please watch our WhatsApp feed for alerts