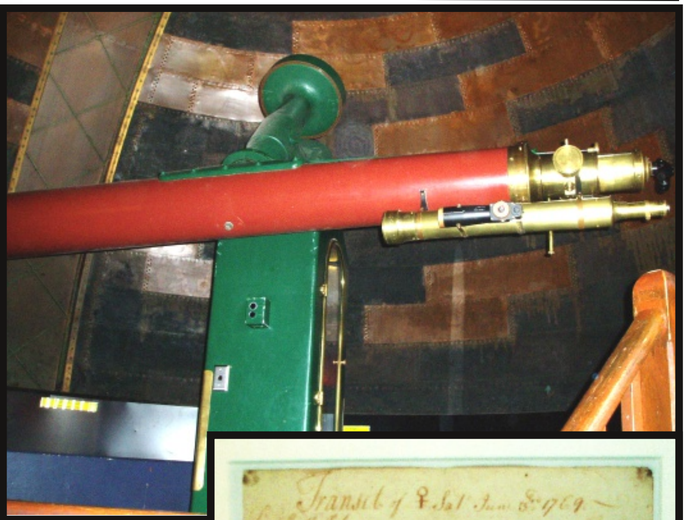
MIRA

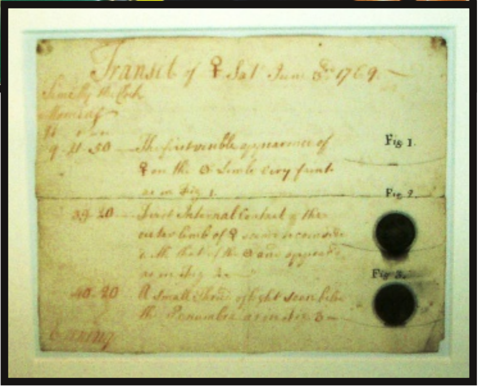
2013.1
Number 95
Price 50p

The Journal of the
Coventry and Warwickshire Astronomical Society
http://www.covastro.org.uk/
covwarksastro@yahoogroups.co.uk



A Return to OZ

Mike Frost at the Sydney Observatory



Selection of pictures for Mike's article on Oz are; the Sydney Observatory and time-ball (on top of tower), telescope in the dome (still in use). A scope on display in the museum and Captain Cook's transit observations. Below are a few of Mike's camera phone pics of the eclipse from the beach at Cairns, Queensland, Australia before and after the total eclipse of November 13th 2012.

CONTENTS

A Return to Oz

By Mike Frost

Twenty-five years ago, in my first foreign posting, I spent a year working at the steel works at Port Kembla, on the Illawarra coast, south of Sydney in New South Wales, Australia. I had a wonderful time. Wollongong, where I lived, is a great place to stay. In my time off I learnt to scuba dive on the Great Barrier Reef, ski in the Snowy Mountains. I climbed Ayers Rock, watched opera in Sydney Opera House; visited Melbourne and Adelaide, Alice Springs and Tasmania. On Australia's 200th birthday, Jan 26th 1988, I joined the celebrations in Sydney; four days later I watched day three of the Bicentenary Test and then saw Pink Floyd in concert at the Sydney Conference Centre. Happy Days!

I made many friends in Australia, not least among the Illawarra Astronomical Society. One of my favourite memories was observing from their bush observatory – a tour of skies completely new to me. I even gave them a talk, "Isaac Newton and the Surrey Pumas" which remains in my repertoire to this day.

Twenty-five years on, it was my fiftieth birthday, and an eclipse of the sun was due to cross the far north of Australia. Time to return! I saved up my annual holiday and splurged three weeks of it at once.

First stop Wollongong – just as good as it ever was. Although Illawarra AS are apparently still extant, they didn't respond to any of my emails. On the other hand, there is now a Wollongong Astronomical Society, and their secretary, Warren Norrie, was good enough to reply. He invited me to his house in Gerringong, a small town further down the coast, where we had a beer, a barbie, and then an observing session. The clouds and the full moon were not on our side (mind you, I was happy to have a full moon as it meant there would be a new moon two weeks later) but we managed a good view of the impressive globular cluster, 47 Tucanae; and investigated the knottiness of the Small Magellanic Cloud, in particular the Tarantula Nebula.

The following night I went along to a full meeting of Illawarra AS. The group are a dozen or so strong, with a very strong emphasis on imaging. Every month they have an imaging target; at the meeting the members vote on the best entries for the previous month's competition, the winner getting to choose the next target. They were kind enough to invite me to say a few words, so I explained about my career in Coventry & Warwickshire AS and the British Astronomical Association, and my visit to Australia a quarter century previously. I ended by saying that Australia was my favourite among the dozen or so countries I had worked in, and, along with New Zealand, my favourite of the fifty or so countries I had visited. *"You were doing OK 'till you mentioned New Zealand"* was the laconic verdict.

From Wollongong I went to the Blue Mountains, west of Sydney, and then Kuringai Chase, to the north, before spending a few days in the city. On my first day, after climbing the Harbour Bridge in the morning, I made my way to a lesser known attraction of the city – Sydney Observatory. In its day the observatory was the most imposing building in the city, but these days it is completely overwhelmed by the southern approaches to the Harbour Bridge. Like the Greenwich Observatory in London, Sydney Observatory was founded for the purposes of accurate timekeeping – for example, both observatories have a time ball, which is raised in the morning and then falls, on the dot, at one o'clock each day.

Sydney Observatory is now an outstation for the Powerhouse Science Museum, which is located a mile away in Darling Harbour (I visited this two days later). It continues to serve the citizens of Sydney by offering observing sessions most clear evenings, and solar observing during the day, as well as a program of talks, films and planetarium sessions. There are displays throughout the observatory explaining the history of the observatory and Australian astronomy and meteorology.

This year, of course, featured two events of great significance to Australia. In addition to the Australian eclipse, there was the Transit of Venus, an event of central significance to the exploration of the continent. You might recall that Captain Cook and Endeavour originally sailed to the Pacific to view the transit of 1769 from Tahiti, as part of the great venture between European nations to view this event from widely differing locations around the globe, and so triangulate the size of the solar system. Only when Cook had completed his observations did he open sealed orders, instructing him to sail south and then west, to discover Terra Australis – as it turned out, New Zealand and the east coast of Australia. Exhibits on display included an excerpt from Cook's records of the transit, and the Janssen apparatus, the revolving camera used to capture images of the 1874 transit from the Blue Mountains.

Most of the visitors were more interested in the upcoming eclipse - either locals, who wanted to purchase eclipse glasses to see the partial eclipse

(67%) from Sydney, or visitors passing through on their way up to Cairns. The observatory staff were frustrated that they would have to stay "on station" at the observatory, rather than joining us for totality. I particularly wanted to meet one member of staff, Nick Lomb, who wrote a really excellent book about the Transit of Venus which I had the pleasure of reviewing for the BAA Journal. Nick, it turned out, had managed to wangle a ticket to Queensland, but I wrote a note to him, which the observatory staff scanned and then emailed to him, so we ended up having an email correspondence, though we never met.

For a grand finale to my return to Oz, I caught the plane to far north Queensland, to join Explorers Tours and their eclipse group. We stayed at Palm Cove, a luxury resort ten miles north of Cairns, and five miles south of the centre-line.

The day before the eclipse we took a boat out to Green Island, on the Barrier Reef five miles out of Cairns. Green Island is a coral cay, surrounded by a reef on which you can snorkel, dive, or take a tour on a glass-bottomed boat (it is now ten years since I last dived, so I was too much out of practice to attempt scuba diving, but I did snorkel). You might think that Green Island had no astronomical connections. Yet it was named, not for its verdant vegetation, but for a member of Captain Cook's crew – the astronomer, Joseph Green, who organised the observations from Tahiti.

One notable feature of the trip to Green Island was the weather. It was very changeable; mostly sunshine, but with sudden heavy rainstorms. Worryingly, the skies were cloudy, with no sign of them clearing. When we held a pre-eclipse briefing on the Tuesday evening, our eclipse expert, the inimitable Dr John Mason, was blunt. The weather could not be micro-forecast anywhere across far north Queensland. So, although we had coaches on hire to transport us inland if necessary, his recommendation was that we stayed put in Palm Cove, because this was as likely as anywhere else to see the eclipse, whilst also offering a later start.

So, it was a 4:30 AM start rather than 2 or 3 in the morning. One by one, bleary-eyed astronomers made their way to the hotel lobby, picked up a breakfast box, and made their way down to the beach. This was already teeming with eclipse observers, some of whom had camped out overnight. I joined up with two friends from previous eclipse tours; Judy Preece of Birmingham AS, and Henryk Klocek of the SPA in London. We strolled down the beach for a few hundred yards, and decided to pitch camp within the safe swimming area, marked by yellow flags, and, more importantly, nets to keep out the stingers (box jellyfish) and saltwater crocodiles – none of us fancied being eaten during totality! The tide was already high and was coming in; with Sun and Moon pulling in exactly the same direction, an unusually high tide was predicted and we had been warned to set up above the tide line, not leaving much room for everyone.

We watched the Sun rise at 5:35, ten minutes before first contact, but within minutes the partially eclipsed Sun has risen into clouds. The skies were not exactly covered with cloud, but a cover of about 30-40% was certainly cause for concern. From time to time sunlight broke through and we could judge progress of the Moon across the Sun. The setting was gorgeous, a palm-fringed beach facing out onto the Pacific and offshore reef-surrounded islands. Ahead of us was Haycock Island, locally nicknamed "Scout Hat" because that's what it looks like when the tide was out and the reef exposed. To our left were the twin hills of Double Island. Along the beach were thousands and thousands of spectators. A helicopter panned along the beach for some crowd shots; Channel 9 broadcast to the nation half a mile south of our pitch. A group of astronomers from southern France set up their equipment on our left.

Time ticked by. If anything, the cloud cover became thicker. There were several layers; a high, thin, slow-moving layer, and more substantial clouds at lower levels, whose motions were difficult to call – we debated which way we'd have to run if the Sun neared the edge of a cloud in the seconds before totality began, and decided we simply didn't know. Fifteen minutes to go, and I began to think that this was going to be an eclipse I was going to miss.

And then a miracle happened. Sometimes eclipses bring on a micro-climate, because the failing solar flux no longer drives the weather. Perhaps this happened in Cairns, or, more likely, we simply got lucky. Either way; first the deeply eclipsed Sun appeared from behind the clouds and then, to our delight, the clouds parted to leave it in the middle of a large gap. Hurry up totality!

Even a minute or two beforehand we weren't certain we'd stay lucky. But as 6:38 approached, we stopped worrying about which way to run and started to realise we were going to see the show in full.

The edge of the Sun narrowed, broke up into Baily's beads – and then the dimmer switch turned off. The roar from the crowd on Palm Cove beach was simply electrifying, and I contributed a few ululations of my own.

I no longer even try photographing eclipses, preferring to concentrate on visual observing, mostly with my binoculars. There were sunspot groups close to the leading edge of the Moon's progress, so immediately there were prominences at three o'clock and six o'clock on the Sun. The solar corona, approaching solar maximum, was symmetrical, with variations toward four o'clock. Venus was clearly visible above the eclipsed Sun, though I didn't bother to find Saturn or Spica, also close by.

The Moon slowly made its way across the Sun, revealing further prominences at the top of the Sun. I could see a few wisps of light cloud crossing my field of view, not enough to obscure too much detail. For the last thirty seconds, I put down my binoculars to try to get a sense of the whole scene. In the last few seconds of the eclipse I watched the edge of the Moon's shadow hurtling in from the north-west across the clouds. As it reached the eclipsed Sun the diamond ring broke through and totality was over – and another huge roar from the crowd. We had seen the whole of totality!

Things get a little manic in the half-hour or so after a total eclipse. Henryk broke out a bottle of champagne, chilled to near-freezing, and we toasted success. I phoned my mum in England *("I thought the eclipse was tomorrow"* she said. *"It is tomorrow, here"* I pointed out). I used my mobile to take a few snaps of pinhole crescents formed by the palm leaves, and the odd shadows which form during the deep partial phase. We made small talk with the French astronomers; fortunately Judy's French was good enough to hold a passable conversation. The clouds returned from time to time, cutting off the Sun, but we didn't care – we'd seen totality!

When we watched the news, and compared stories with other umbraphiles, we realised that we had been lucky at Palm Cove. Thousands watching from central Cairns had missed totality altogether. At the top end of the eclipse track, around Port Douglas, cloud cover wasn't total, but most people only saw part of totality. Observers close to the centreline fared better, and those inland (including the Astro-Trails party from the UK) mostly had an unobstructed view of totality.

It was my first total eclipse for six years, my eighth time under the lunar shadow (five successes, two complete failures and an all-but-failure in 2002, when I should have been in South Australia rather than Mozambique), and one of the more spectacular eclipses I have watched – I think, due to the presence of clouds. And Palm Cove made a perfect backdrop.

The eclipse was the last act of a fantastic holiday, and the next day I was off back to England. In Sydney airport, there was one final surprise. I shared the terminal transit bus with Kate Humble and a BBC camera crew. They were filming for a BBC2 series on the solar maximum, due for transmission around next March. Watch out for it – in the helicopter shots, I'm the one by the stinger nets, waving at the camera!

MERCURY

By Paritosh Maulik

Being the closest planet to the Sun, at noon the temperature on Mercury may rise to 450°C, but at night it could drop to -180°C. There are regions with water ice, mainly around the poles. It was imaged for the first time by the Mariner 10 probe in 1974. The surface is heavily cratered like the Moon. The density of the planet is very high. The atmosphere is very thin and is unlike other terrestrial planets and Mercury has a magnetic field. Meet the little known world of Mercury.

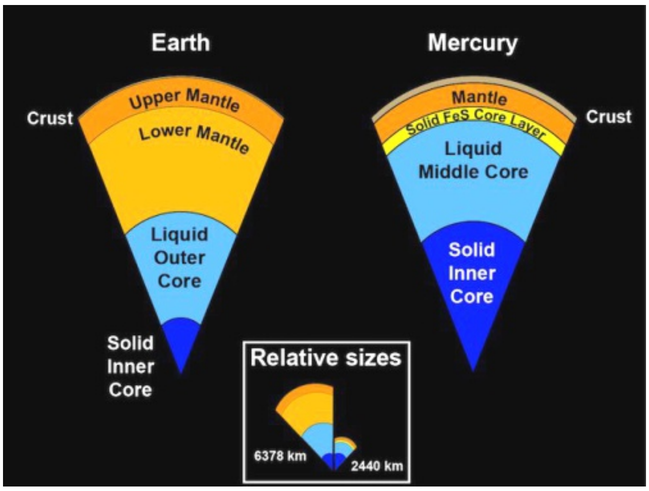
General features

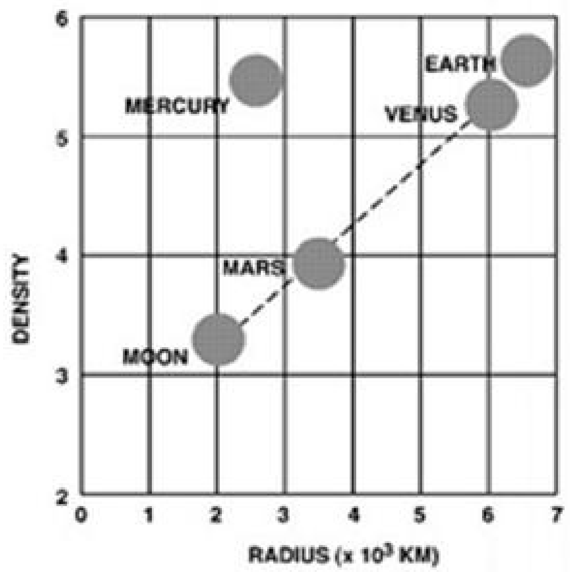
Mercury, the planet nearest to the Sun, is the second smallest planet; Pluto being the smallest. Its orbit is highly elliptical; at perihelion it is 46 million km from sun and 70 million km during aphelion. The orbit of Mercury does not obey the Newton's law of gravity. It is the bending of space – time, predicted by the general theory of relativity, which gave the correct solution in 1989. The enormous mass of the Sun bends the space–time and affects the orbit of Mercury.

The rotation of Mercury is much slower than that of the Earth. Until 1965 it was thought only one face of Mercury points to the Earth, in fact, it rotates only three times during its two orbits around the Sun. In 58.646 Earth days Mercury rotates once around its axis, one sidereal rotation. Its average orbital speed is about 47km per second.

Mercury is the most dense of the terrestrial planets, its density is about 5.43g/cc. For the terrestrial planets, including the Moon, the size and density follow linear relationship; the density increases with size, but Mercury does not follow this trend, its density is much higher. The suggested reasons are

1) Iron was high in the primal nebula, from which the planet formed. Iron is a heavy element.





Density of the terrestrial planets increases with size, but Mercury does not follow this trend; it much denser.

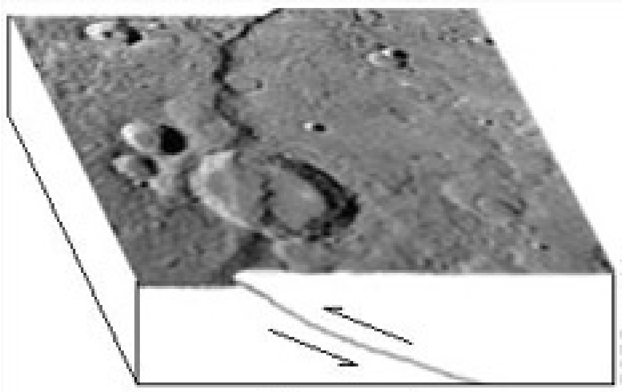
2) Some of the oxides have been reduced by the solar radiation into metals; metals are heavier than their oxides,
3) The lighter outer silicate crust has been removed by solar radiation and heavy meteorite bombardment which has blasted away much of the outer rocky mantle leaving the behind the heavy iron core.

Mercury has a large iron content; about 70% of it is iron and other metals in its core. This accounts for about 75% of its diameter and about 40% of the volume, whereas for the Earth it is about 17%. The outer mantle is silicate minerals, about 600km thick, and the crust is about 100 – 300km thick.

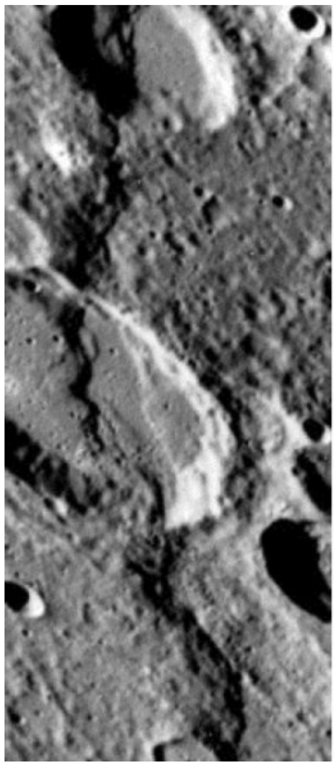
Surface features of Mercury

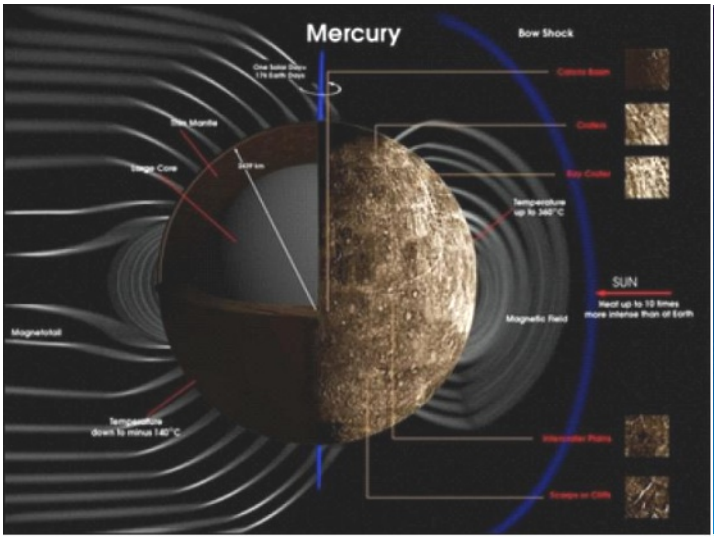
The surface of Mercury is heavily cratered, being close to the Sun it was heavily bombarded by rocky bodies. These were travelling at high speed under the Suns gravity and there was no atmosphere to break their fall. In between the craters there are lava covered plains, their origin is due to volcanoes. Volcanic activities stopped about 4,000 million years ago and the majority of the bombardment occurred about 3,500 million years ago. Now all the volcanic activities have ceased.

On the surface of Mercury there are surface ridges. These are thought to be have been formed

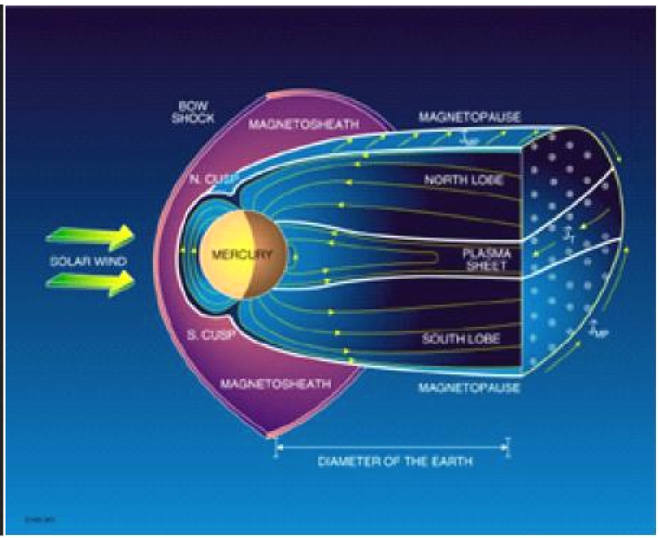

Discovery Rupes schematic


The heavily cratered surface of Mercury


A Geological fault on the surface of Mercury



The Magnetic field of Mercury



Solar Wind flow around Mercury

during the cooling of the mantle; as the mantle cooled down, it stank and formed wrinkles (geological faults). These ridges can pass over a wide area, including craters and plains. The gravity of the Sun on Mercury is about 17% stronger than the effect of the Moon on the Earth. The high gravitational force of the Sun might have played a role in the formation of the surface features on the planet.

The Atmosphere of Mercury

Mercury does not have an atmosphere like the other rocky planets, but it is surrounded by a thin envelop of gases called exosphere. This "atmosphere" is very thin; so thin the atoms do not collide with each other, but just move about. It is made up of neutral atoms blasted off its surface by solar radiation, solar wind and striking micrometeoroids. Because of the planet's extreme surface temperature, the atoms quickly escape into space. This exosphere contains hydrogen and helium, likely from the solar wind and other elements like oxygen, sodium, potassium and calcium. NASA's MESSENGER mission detected the presence of magnesium. These heaver elements are likely to be from the meteorites and comets striking the planet. Since there is no atmosphere, meteorites do not burn up as these approach the planet and this process also causes crater formation and there is little or no wind erosion of the planet's surface.

Water on Mercury

The first evidence of the possible presence of water on Mercury came from the radio telescopes. Despite being so close to the Sun, the Polar Regions of Mercury can be around -100°C and some deep crater can be as cold as -170°C; the Sun never reaches these deep craters. Radar images from Mariner 10 suggested the presence of water in the deepest craters. The temperature is so low that even the ultra-low pressure of space does not sublimate the ice. However it has been suggested that the strength of the signal from the ice is not very strong. One possible reason may be the ice is in a powdery form and is thinly spread or alternatively the radar signal is due to the presence of reflective minerals. It is believed that the ice has been carried by comets which bombarded the surface of the planet in the past.

The Magnetic field of Mercury

The magnetic field of both Mercury and the Earth are similar in that, as if there is a giant bar magnet at the centre of these two planets. The magnetic behaviour of Venus, Mercury and Moon is due to localised rock deposits. The magnetic field strength of Mercury is about 1% of that of the Earth. But it is very active. Regularly it connects to the magnetic field of the Solar wind; this creates strong magnetic tornadoes to the surface. The solar wind plasma comes down to the planet's surface and neutral atoms are lifted off from the surface to high altitude; some of these fall back to the surface and some leave the planet.

The rotating molten iron core of the Earth is the reason behind the Earth's magnetic field. It is called the dynamo effect. As nearly two thirds of Mercury is made up of iron, so Mercury is expected to have a strong magnetic field. Recent theoretical modelling suggests that the magnetic field associated with the solar wind penetrates deep into the planet and weakens the magnetic field of the planet. The details of the magnetic behaviour of Mercury are to be examined by the MESSENGER and Beppi Colombo missions.

Missions to Mercury

Mariner 10 was launched in 1973 to orbit both Venus and Mercury. It orbited Mercury three times and its major achievements are:

1) High resolution images of Mercury. Terrestrial instruments could not produce high resolution images of Mercury, so Mariner 10 images were the first high resolution images of the highly cratered surface of Mercury

2) Detected the thin exosphere
3) Noted the presence of the magnetic field
4) Measured the surface temperature.

MESSENGER (MErcury Surface, Space ENvironment, GEochemistry and Ranging) was launched in 2004. After many complicated flybys around Earth, Venus and Mercury, the spacecraft finally entered the orbit of Mercury in 2011. After about one year in its mission, by 2012, it has sent back about 100,000 images. It has just completed its primary mission and the mission now has been extended till 2013. It is to collect information on chemical composition, geology and the magnetic field.

Beppi Colombo is the first European mission to Mercury with Japan Aerospace Exploration Agency (JAXA) as a collaborator. It is will be launched in 2015 and is expected to reach Mercury in 2022. The duration of the mission is one year, but may be extended for another year. There will be two spacecrafts, the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO).

Objectives of the Beppi Colombo mission

The composition of Mercury may throw some lights on the solar nebula that formed the planets of the solar system.
The reason behind the high density of Mercury.
The nature of the core of Mercury and its effect on the magnetism of the planet.
Tectonic activity on Mercury.
Iron is a major constituent of Mercury; yet the spectroscopic observations do not show the presence of iron in Mercury.
Examination of the evidence of water; is it water or some other minerals?
High resolution imaging of the surface of the planet.
Formation of the exosphere.
Interaction of the solar wind with the magnetic field of the planet.
Does aurorae form on Mercury like the Earth? Is there a radiation belt?
Since the orbit of Mercury is influenced by the high gravity field of the Sun, it may be possible to test the theory of general relativity with higher accuracy.

Possible Russian mission to Mercury? There is some talk about a possible Russian mission to Mercury, but very little details are available.

MESSENGER

(MErcury Surface, Space ENvironment, GEochemistry, and Ranging)

a NASA mission; update

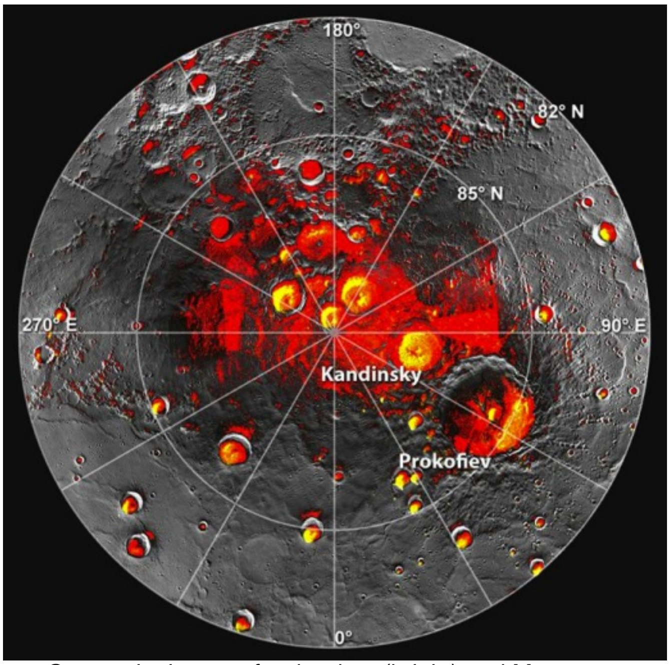
By Paritiosh Maulik

The mission was launched in August 2004, and entered orbit about Mercury in March 2011. It has collected data for a year and now it running an extended mission since March 2012. Some of the preliminary results from Mercury have been released recently.

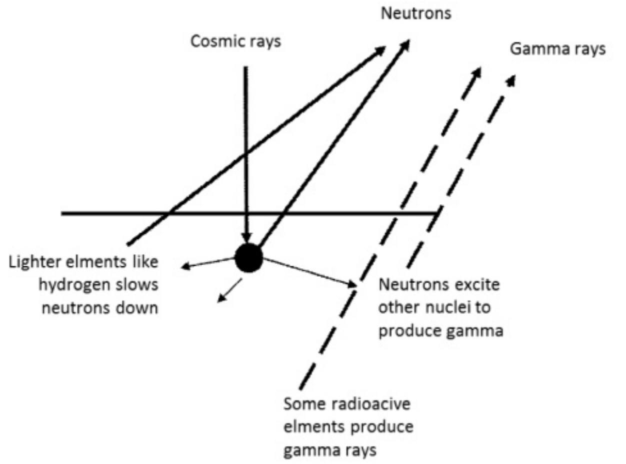
Presence of water

Mercury is very close to the Sun and therefore it was thought that the surface temperature would be too high to find any water. The surprise came in 1970 when NASA's Mariner probe detected presence of water ice in several craters. The Mariner probe only covered about 50 percent of the planets surface. The Arecibo radio telescope suggested the presence of water near the polar regions in 1991. The tilt of the planet is less than one degree, so certain areas, such as deep craters rarely see the Sun. These areas could be cold enough to retain water. One of the tasks of the Messenger mission was to carry out a detailed examination of the surface chemistry of Mercury.

Optical images from Messenger suggested the presence of water. The presence of water was also supported by other measurements.



Composite image of radar data (bright) and Messenger (grey); bright areas were identified as possible sites for water ice on Mercury.



Generation of gamma rays and neutron by cosmic rays

A Neutron Spectrometry measured the hydrogen concentration of the areas which were previously identified by the radar observations as the possible sites for water to occur. Neutron spectrometry results indicate that there is a surface layer of 10 – 20cm thick which contains hydrogen; beneath this surface layer there is another layer, with still higher hydrogen level and the hydrogen is in the form of water ice. The average thickness of the water ice layer is several tens of centimetres. The Mercury Laser Altimeter instrument aboard the Messenger probe mapped the planet's surface with laser pulses. The reflected beam showed there are dark and bright areas on near the planet's north pole. The bright areas corresponded to the possible water containing regions suggested by the ground based radar observations. The intermediate dark areas are thought to be due to an insulating area covering the ice. The scientists think that both lower hydrogen bearing darker material and higher hydrogen containing brighter materials probably have been deposited by asteroids.

Thermal Modelling of the surface topography, as measured by the laser mapping data, suggests that theoretically it is possible to have certain regions on the surface of Mercury, where the temperature is low enough for surface water (ice) to be stable.

Some of the dark materials on the surface of the Mercury could be organic molecules. Some of the organic molecules have been further darkened by the harsh radiation on the surface of Mercury. If this is the case, then it is likely that comets and asteroids have bought water and organic molecules to Mercury, as on other terrestrial planets.

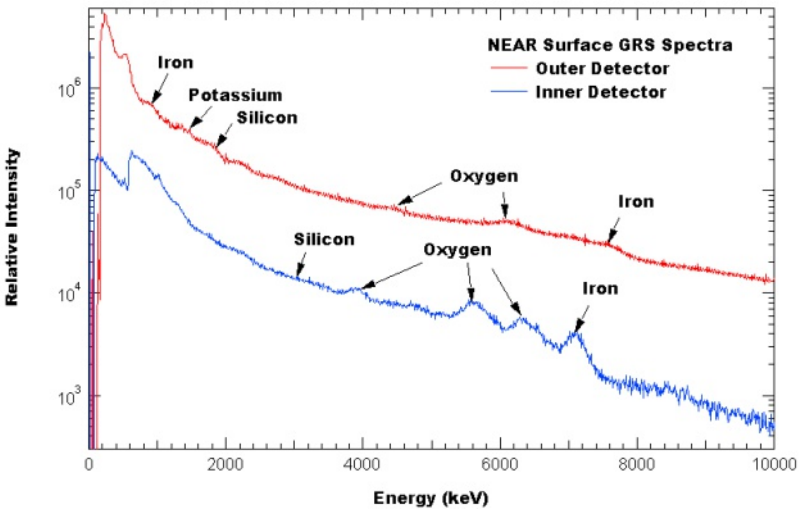
Mercury Surface Chemistry

The mission also carried a x-ray spectrometer. Solar x-rays hit the surface of Mercury and the elements present on the surface gives off fluorescent x-rays. X-rays from each element has its own characteristic energy level. By measuring the energy of the x-ray, we can identify the elements. From such measurements it seems that the composition of the older regions (highly cratered) is different from the volcanic smooth plains. This means that, the composition of the magma, caused the volcanic activity had a different composition to that of the older regions. The possible explanation may be that different areas of the mantle of Mercury melted at different times and volcanic activity has caused localised variation of surface chemistry.

The sulphur level on the surface of Mercury is much higher than that of the Earth and Mars. On Earth, minerals formed from very hot lava tends to contain a high percentage of magnesium. A similar process also might have occurred on Mercury.

Neutron spectrometry

Cosmic rays are mainly high energy protons, from the Sun or other high energy astronomical sources. On the Earth, the majority of the cosmic rays are absorbed by the atmosphere, but since there is no atmosphere on Mercury, majority of the cosmic rays reach the surface. When the fast moving cosmic rays strike with an atom on the surface of Mercury, the nucleus emits a neutron. Some of these neutrons react with the nuclei of other elements; the nuclei go to a higher energy level and eventually the nuclei return to the low energy state by releasing the excess energy. Some of the excess energy is released as gamma rays. Radioactive elements like uranium and thorium in the planet's surface also release gamma rays. Neutron and gamma rays from mercury are analysed by Messenger. Gamma rays are analysed by a semiconductor device and the neutron beam is analysed by a scintillation counter. These two devices measure the energy of the neutron and gamma rays, each element gives off these rays at characteristic energy level. The energy identifies the element and intensity of the beam is an indication of the quantity of the element.



A typical spectrum plot from the Messenger probe

Some time in the next 105 years I'm going to stop banging on about Jeremiah Horrocks.

But not just yet…

Jeremiah Horrocks and New England

By Mike Frost

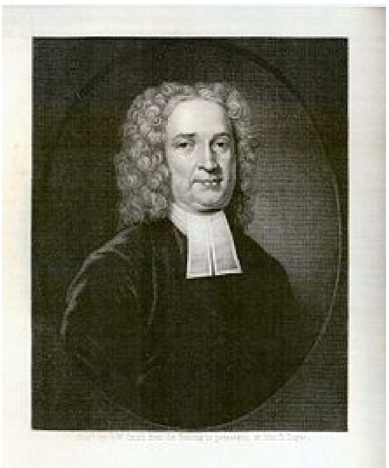
Every time I give one of my talks on Jeremiah Horrocks and his contemporaries, I have been recommending *"Jeremiah Horrocks, The Transit of Venus: The brief, brilliant life of the father of English Astronomy"* by Peter Aughton. I had the pleasure of meeting Mr. Aughton on Transit Day, 2004, and he signed my copy of his book.

I think the Horrocks biography is a well-written and enjoyable book, but let me show you somewhere where I think it is wrong. It's the story of Jeremiah Horrocks's connections to the New World.

You might remember from my previous articles that Jeremiah Horrocks was a Puritan, a Liverpudlian, and a student of Emmanuel College in Cambridge University. In the seventeenth century, all three groups were a fertile source of colonists for the new settlements on the far side of the Atlantic.

The Mayflower landed at Plymouth Rock, Massachusetts on 1620. This wasn't the first successful English colony in America; that was Jamestown, Virginia, founded eight years previously. But during the 1620s and early 1630s the New England colony thrived, centred on what is now the city of Boston. The leading political figure in the Massachusetts Bay Colony in its early years was one John Winthrop, governor for 12 of its first 20 years.

The primary reason why people emigrated to America was the splintering of religious faith which racked England during the seventeenth century. In the previous century, Henry VIII had split England from the catholic faith, to form the established, Anglican church. But congregations disagreed over the fine points of theology and of practice. Many of the American colonists had a Puritan, "back-to-basics" view of faith, eschewing ceremony and finery. Back in England, Emmanuel was the intellectual centre of this viewpoint and so many of students from the college ended up in New England; most notably John Harvard, founder of Harvard University. One of the most important of the New England colonists was John Cotton, a preacher from Boston, Lincolnshire, who sailed to Boston, Massachusetts to escape Archbishop Laud's purges of the Puritans. Cotton's first wife, who died in 1631, was Elizabeth Horrocks, Jeremiah's cousin. Cotton remarried a year later and sailed to America with his second wife in 1633.



John Cotton

It would be wrong to assume that the Puritan movement was unified. In the New England colony, followers of different sects within Puritanism squabbled with each other. Between 1636 and 1638, for example, occurred the Antinomian (Free Grace) dispute. Anne Hutchinson, a midwife from Alford, Lincolnshire, a woman described as 'disruption personified', engaged the colony in a series of theological debates. Their nature is impenetrable to me, although modern day writers tend to interpret them in gender terms (which may prove equally impenetrable to future generations). Anne Hutchinson was put on trial in 1637 for traducing [slandering] ministers. John Cotton, who had preached to her in Lincolnshire, initially supported her. The result of the trial was that Anne, her family, and her followers, the Hutchinsonians, were banished from the Massachusetts Bay colony. They made their way to undeveloped land to the south of the colony in what is now the state of Rhode Island.

In Rhode Island today the first settler is celebrated as one William Blackstone, a graduate of Emmanuel who arrived in 1635. However, Blackstone was a loner rather than the founder of a colony; additionally he settled in the portion of the colony closest to Massachusetts. The first two colonies in Rhode Island were both founded by groups ejected from Boston. The full name of the state, the "State of Rhode Island and Providence Plantations" commemorates the first two colonies – one on the mainland, centred on what is now the state capital of Providence; and the other on Rhode Island itself, now home to the millionaire mansions of Newport. The first colony in Providence was founded by Roger Williams in 1636, and the first settlers of Rhode Island were the Hutchinsonians, who arrived in 1638. With Roger Williams' help, the Hutchinsonians purchased the island from the local tribe, the Wampanoag, and called it by its Wampanoag name, Aquidneck. (The name Rhode Island came later – possibly from the Dutch for reddish, "Rodish"; or perhaps from a supposed resemblance to the Greek island of Rhodes)

Why am I interested in these settlements? Because Peter Aughton connects Jeremiah Horrocks to the Rhode Island settlement: *". . .we discover that Jeremiah was still in touch with his cousin Thomas Horrocks, whom he had known at Cambridge, and who had emigrated to America with his uncle (-in-law) John Cotton. Jeremiah asked his American cousin to estimate as accurately as he could the local time from the first recovery of the Moon's light after the lunar eclipse of 1638 until the sunrise on the same day. . . The observation is traditionally thought to have been made from the place now known as Quidnick in Rhode Island"* (Aughton, p. 147)

Aughton had already written about Thomas Horrocks and a lunar eclipse. *"There were observations of an eclipse of the Moon on 10 December 1638 by William Gascoigne. . . The lunar eclipse had also been observed by Jeremiah Horrocks and he had tried to use the data to calculate the longitude of a point on the American continent by comparing his timings with the observations of Thomas Horrocks, his American cousin".* (p.9) This eclipse was also seen by Samuel Foster, John Twysden and John Palmer from New House, Coventry, and I have often used the tale to illustrate how longitudes could be calculated by careful observations of lunar eclipses, a method known to ancient Greek astronomers.

However, there is a problem. On page 147, Aughton goes on to date the lunar eclipse to June 1638, following soon after a solar eclipse in May of that year. You can see that on page 9, Aughton refers to a December eclipse, and on page 147 a June eclipse. Two separate events are combined.

I have a particular interest in New England because I have my own connections to that part of the world. One hundred and eight years ago, in 1905, my maternal great-great-grandparents and five of their six children left the cotton mills of Lancashire for the cotton mills of Rhode Island, leaving behind their eldest daughter, my great-grandmother, who was already engaged to my great-grandfather. So the states of Rhode Island and Massachusetts are full of third cousins of mine. My mother corresponded with several of them and, in 1998, I chauffeured my parents when we visited Rhode Island to meet the relatives. They turned out to be the most welcoming and friendly people, and I have stayed in touch with many of them subsequently.

My third cousin Jim Collinson knows of my interest in astronomy, and drew my attention to an article in the Providence Journal about the Transit of Venus in June 2012, mentioning Jeremiah Horrocks and William Crabtree. I wrote to Sheila Lennon, the author of the article, to ask if she was aware of the connections between Jeremiah Horrocks and Rhode Island. Sheila smelt a good story and wanted to find out more. We exchanged a number of emails, where I detailed my sources. Sheila then began to research the story from her own perspective.

What she found wasn't quite what either of us expected.

On June 23rd she emailed me: *"I have a found Thomas Horrocks, age 22, on the manifest of the ship George on Aug. 21, 1635. The ship went from London to Virginia. Jamestown."*

Thomas Horrocks did NOT emigrate to Rhode Island!

So what's the real story? Which lunar eclipse of 1638 was observed from America? Was it really observed from Rhode Island, and if so, by whom?

As a historian of astronomy, I should have known exactly how to resolve these questions – *go to the primary sources.* So let's see exactly what Horrocks actually said. I've attached the relevant bit from Horrocks's Opera Posthuma. It says:

"Ultimum exemplum nuper mihi communicarum est. Anno 1638, Junii 16 observavit quidam, inter primam recuperationem luminis in Ecclipsi Lunae, & ortum visibilem, suisse horam 1.5' per horologium. Hoc suit loco quodam Nova-Angliae, quem ille vocat Aquedniek, sub elevatione Poli 40.50'. Sol oriebatur vere hor. 4.32', per refractionem h. 4.28', ergo totales tenebrae desinebant hora 3.23 mane. Goesa hoc suit hora 8.53'. ex calculo Lansbergii. Hinc differentia Meridianorum, hor. 5.30. sed nolis huic confidere, incertus enim calculus, nec omnino exacta observatio."

Between my Latin O-level and Google translator, I think this translates as:

"The last example is a recent communication to me. In the year 1638, on June 16, 1 hour and 5 minutes elapsed between the recovery of light after a lunar eclipse, and the rising of the Sun. This happened in a place in New-England called Aquedniek, at a latitude of 40.50' [it's actually at 41.55']. *The sun rose at 4:32AM, 4:28AM after correction for refraction, so total darkness ceased at 3:23 AM. At Goes* [in the Netherlands] *this happened at 8.53 AM from the calculations of Lansberg. Hence the difference of the meridians is 5 hrs. 30 minutes. But you do not want to trust this completely, for the calculation is uncertain, and the observation not exact."* [Goes is actually 3.9 deg E of Greenwich, and Aquidneck 71.3 deg W, so the difference in longitude is 75.2 degrees which corresponds to approximately 5 hours 1 minute in time]

You can see that the observation genuinely was made from Aquidneck. You can also see that no name is mentioned (and you can also see that Horrocks didn't place much faith in the accuracy of the calculation). So there is no evidence from Jeremiah Horrocks that it was his second cousin Thomas who made the observation.

I wrote to Peter Aughton to find out if there was a source he had used which I had missed. Peter was kind enough to email me back. His main source for Horrocks's family history was a 1954 paper by Sydney Gaythorpe in the Proceedings of the Lancashire and Cheshire Historical Society. Here's what Sydney Gaythorpe had to say:

". . .another somewhat distant relation of Jeremiah's, and one, perhaps, who contributed his mite to his young kinsman's store of astronomical observations, was Christopher Horrockes of Bolton-le-Moors, fuller[wool cleaner]. . . . He was probably a cousin of Jeremiah's father . . . It is well known that Christopher the fuller and his family, with the exception of his only son, Thomas Horrocks, then a sizar at St. Johns College, Cambridge, accompanied the Reverend John Cotton, when the latter sailed for New England on 16 July 1633. And there can be little doubt that this Christopher Horrockes, or some member of his family, was the un-named correspondent who communicated to Jeremiah the time interval of 1h 5m by the clock . . . as observed at Aquidneck."

So it appears that identifying Thomas Horrocks as the observer was due to a mis-reading of Gaythorpe's paper. According to Gaythorpe, Thomas Horrocks did not travel to New England; Gaythorpe added a footnote to say that Thomas became a minister and died in Battersea in 1687, so the Virginia Thomas Horrocks may not even have been related. On the other hand, a new candidate has emerged – Thomas's father, Christopher Horrocks, who sailed with his in-law John Cotton to New England in 1633. The phrase *"it is well-known that. . ."* hints at further sources not known to me; my researches tell me that John Cotton arrived in New England on a ship called the Griffin, but there is no extant passenger list for that voyage, so I can't confirm Gaythorpe's assertion (we do have a passenger list for the Griffin's next voyage from England to New England; it includes Anne Hutchinson and her family). And even Sydney Gaythorpe can't say for certain that it was Christopher Horrocks who made the lunar eclipse observation.

In fact, we haven't found out who the observer was. Sheila Lennon made the very valid point to me that the observation of a lunar eclipse was one which could have been made by many people. Moreover, a much greater proportion of the population would have been interested in such activities than in our society today. These were practical people, used to doing their own surveying, building their own houses. The timing of a lunar eclipse, although in some ways trickier then than now, would also have been feasible – for without clocks, how else could you tell the time at night other than by the stars? Many colonists would be familiar with the concept of using the Plough pointers as clock hands, estimating a time interval from the angle through which they turned.

Sheila Lennon dug a little deeper, and turned up a fascinating story, detailed in a website by Christy K. Robinson, a twelfth-generation descendant of the first Rhode Island settlers.

Remember the context – the colony of Rhode Island was founded by the most fanatical of the Puritan settlers, the ones who had not only followed their faith from Britain to America, but had then fallen out with their fellow Puritans in Massachusetts, had once again turned their backs on society, and had pushed on into the "wilderness" of Aquidneck (Rhode) Island.

Aquidneck was a tiny, deeply religious, community, in a life-and-death struggle to establish itself in a hostile environment. And on Tuesday June 1st 1638 they suffered a terrifying setback. In the early afternoon, an earthquake of about magnitude 6.5 – 7.0 hit the fledgling colony. An aftershock followed half-an-hour later, followed over the next few weeks by several more.

A number of contemporary accounts exist. This is from the journal of Governor John Winthrop: *"June 1. Between three and four in the afternoon, being clear, warm weather, the wind westerly, there was a great earthquake. It came with a noise like a continued thunder or the rattling of coaches in London, but was presently gone. It was at Connecticut, at Narragansett, at Pascataquack, and all the parts round about. It shook the ships, which rode in the harbor, and all the islands, etc. The noise and the shakings continued*

Governor John Winthrop

about four minutes. The earth was unquiet twenty days after, by times."

Winthrop also recorded a hearsay account of the earthquake in Rhode Island: *"On the first of June 1638, there was an earthquake which continued about four minutes and left the earth in an unquiet condition for twenty days afterwards. Mrs. Hutchinson and some of her adherents happened to be at prayer when the earthquake was at Aquiday, etc., and the house being shaken thereby, they were persuaded, (and boasted of it,) that the Holy Ghost did shake it in coming down upon them, as he did upon the apostles"*

For a fanatical religious community, the lunar eclipse of June 18th took on great significance. Revelations 6:12 describes the prophecies of the end of days: *"and lo, there was **a great earthquake;** and the sun became black as a sackcloth of hair, **and the moon became as blood"***. What could be a clearer sign to the Rhode Island colonists? Moreover, the Earthquake came at the time of Pentecost, the descent of the Holy Spirit onto the apostles – admittedly not a festival celebrated by Puritans; but surely, in the minds of the colonists, not a co-incidence.

Of course, the settlers took the earthquake and the eclipse as a direct message from God – chastising the sinful for their wicked ways. Roger Williams writing to John Winthrop: *". . .in the affairs of the Most High; his late dreadful voice and hand: that audible and sensible voice, the Earthquake. All these parts felt it, (whether beyond the Narragansett I yet learn not), for myself I scarce perceived ought but a kind of thunder and a gentle moving, &c., and yet it was no more this way to many of our own and the natives' apprehensions, and but one sudden short motion. The younger natives are ignorant of the like: but the elder inform me that this is the fifth within these four score years in the land: . . . and they always observed either plague or pox or some other epidemical disease followed; three, four or five years after the Earthquake, (or Naunaumemoauke, as they speak). He be mercifully pleased himself to interpret and open his own riddles, (and grant if it be pleasing in his eyes) it may not be for destruction, and but (as the Earthquake before the Jailor's conversion) a means of shaking and turning of all hearts, (which are his,) English or Indian, to him. To further this (if the Lord please) the Earthquake sensibly took about a thousand of the natives in a most solemn meeting for play, &c."*

Needless to say, everyone came to the conclusion that God's message was that they were only ones on the right path, and everyone else on the wrong path!

So, what do we learn from the story? It's possible, but not at all proven, that it was Christopher Horrocks who timed the lunar eclipse of June 1638; it certainly wasn't Thomas Horrocks. On the other hand, there were many people who had a great interest in this eclipse, because of the previous earthquake and for reasons of their extreme faith, and many of these people would have been quite capable of making the timings which Horrocks quotes. We also know that there were boats like the Griffin which made multiple crossings of the North Atlantic, and it would be easy to suppose that the settlers in the colonies sent news of their adventures back to the old country.

You can imagine Christopher Horrocks adding a P.S. to a letter home, asking the recipient to send news of lunar observations back to the "curious astronomer" in rural Lancashire – perhaps not even observations he had not made himself, but had heard from the fanatical Hutchinsonians of Rhode Island.

We may never know the whole story.

Sources:

"The Transit of Venus: The Brief, Brilliant Life of Jeremiah Horrocks Father of British Astronomy", Peter Aughton (Weidenfeld and Nicolson, 2004)

"Jeremiah Horrocks – Date of Birth, Parentage and Family Associations", Sydney Gaythorpe (Proceedings of the Lancashire and Cheshire Historical Society, Volume 106, 1954, pp.23-33).

"A History of Emmanuel College Cambridge", Sarah Bendall, Christopher Brooke and Patrick Collinson (Boydell, 1999)

The *"Complete Book of Emigrants: 1607-1660"* lists a Thomas Horrocks, age 22, as a passenger on the George from London to Jamestown. See: http://books.google.co.uk/books?id=vWDV4Fk7TmAC&pg=PA164&lpg=PA164&dq=thomas+horrocks,+london,+virginia&source=bl&ots=YhsbOyrUeN&sig=tykeBSn7WWN7WPHyJCLQz3ARUJo&hl=en&sa=X&ei=BTLRT8a5DsPi2QWV1NmdDw&redir_esc=y#v=onepage&q=thomas%20horrocks%2C%20london%2C%20virginia&f=false

or http://www.tinyurl.com/thomashorrocks

"The great New England quake of 1638", by Christy K. Robinson explores the religious context of the quake, see: http://marybarrettdyer.blogspot.co.uk/2011/09/great-new-england-quake-of-1638.html

or http://www.tinyurl.com/RIquake1638

I am very grateful to Sheila Lennon for her researches into the early days of the Rhode Island colonies.