

Preface

My acquaintance with Mercury goes back a number of years, long before we had intimate views of it like the one in Fig. 1. I first saw it as a schoolboy from my parents' home in Kings Norton, Birmingham, on 14 February 1974 (I still have my observing logbook). I had found out that Mercury was approaching elongation, and on a rare evening with no cloud on the horizon, I swept the sky with my trusty 7×50 binoculars above where the Sun had set about half an hour before. Eventually, there it was – way to the left of the Cadbury's chocolate factory and the more distant university clock tower, a rose-tinted speck of light just as described in

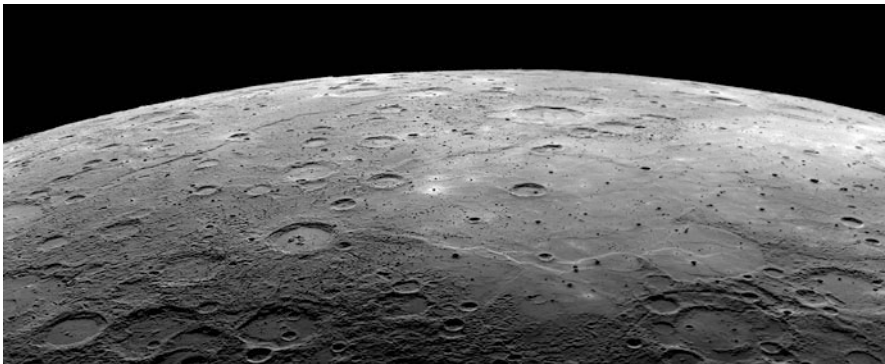


Fig. 1 A mosaic of MESSENGER NAC (Narrow-Angle Camera) images looking west across the limb of Mercury as seen during its approach to flyby 2 in July 2009. The Sun illuminates the terrain at a grazing incidence angle. This is as representative a view of Mercury's general terrain as you will find anywhere. The foreground and left are dominated by cratering and general impact architecture. On the right and extending across the background are lava plains, which have evidently flooded the cratered terrain. Wrinkle ridges and lobate scarps deform the lava plains. Shadowed impact craters as small as about 1 km in size show up as black specks scattered throughout. The peak-ring crater in the foreground at the extreme left (south) of this view is named Steichen and is about 180 km across (NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington)

Patrick Moore's books from which I had picked up my astronomy and, such as it was in those days, my planetary science. I was unable to make Mercury out with the naked eye before it sank into the murk, and having ticked it off my mental list, I did not see it again for a long time though I did manage brief glimpses of Mercury's silhouette projected using the Birmingham Astronomical Society's 12-in. reflecting telescope as it transited across the Sun in November of the same year.

All this took planning. Mercury is not a planet that draws attention to itself unlike Venus, Mars, Jupiter and even Saturn – all of which can be prominent bright objects high in a dark sky.

In 1978, about to graduate in geology and looking for a PhD position, I went to see John Guest at the University of London's Mill Hill Observatory. We spoke about a project on Mars, but on parting John gave me a copy of the June 1975 special issue of *Journal of Geophysical Research* containing the first lengthy papers arising from the first two Mariner 10 flybys of Mercury. I perused this with interest, but Mercury once again dropped below my radar as I began a PhD at the Open University (where I have been based ever since), using a mixture of satellite images and fieldwork to map part of the Oman mountains in Arabia.

Fast forward to May 1994, a few months before I was promoted to Senior Lecturer in Earth Sciences at the Open University. By then, I had a lot of terrestrial, and some martian, remote sensing under my belt. A team of scientists had submitted a proposal for a Mercury orbiter to the European Space Agency in 1993, and there was now to be a mission selection meeting at ESA headquarters in Paris. John Guest, who was one of the proposers, was unable to attend. The team felt the need of someone to present a geological case for renewed exploration of Mercury, and so I was recruited at short notice to fill the gap. I mugged up on Mercury (making liberal use of that *Journal of Geophysical Research* gift!), said my piece in Paris, and then stepped back out of the loop. It was not until 2000 that ESA gave approval for an ambitious 'Cornerstone' mission to Mercury named BepiColombo, consisting of two orbiters and a 44 kg lander. The lander was cancelled for budgetary reasons in 2003, by which time NASA had overtaken ESA and prepared a less ambitious single-orbiter mission called MESSENGER that was launched in 2004. This achieved orbit in 2011 and has provided most of the new data that justify this book.

In the meantime, in 2004 I found myself on a 'project peer review panel' convened by the relevant UK funding agency (in those days PPARC, the Particle Physics and Astronomy Research Council) to vet proposals from UK groups to ESA's call to provide instruments for BepiColombo. Our task was to recommend which, if any, should be funded.

We wanted to fund two instruments, but in the end only barely enough funding was forthcoming for one. This was the Mercury Imaging X-ray Spectrometer, MIXS, led by a team from Leicester University. It would be capable of measuring the abundances of elements on Mercury by mapping X-rays of characteristic energies fluoresced from the surface because Mercury's airless landscape is bathed in broadband X-rays emitted by the Sun.

For 2 years, I served on PPARC's BepiColombo oversight committee, whose job was to scrutinise expenditure and monitor progress, before I 'switched sides' and

joined the MIXS team as Lead Scientist. This gave me an entrée to ESA's BepiColombo science team, and I soon found myself leading ESA's Mercury Surface and Composition Working Group. Thanks to an attitude of mutual cooperation between NASA's MESSENGER team and ESA's BepiColombo team, I have also been able to attend various MESSENGER science team meetings.

Thus, I have had a ringside seat to observe much of the planning of two Mercury missions and the staggering unveiling of Mercury achieved by MESSENGER. BepiColombo is due for launch in 2016 and should return its first data from orbit in 2024. It will carry more, and generally more sophisticated, instruments than MESSENGER. We expect it to answer many of the questions left open by MESSENGER, but it will undoubtedly pose numerous new questions of its own. That is how planetary exploration progresses.

In the meantime, this is a good juncture at which to tell Mercury's story. I want to show that it is not a mere pink dot in the sky. Thanks largely to MESSENGER, it stands revealed as a world with a long and complex geological history, surrounded by a dynamic exosphere and magnetosphere, and with superbly sculpted and mysterious landscapes such as the one shown in Fig. 2.

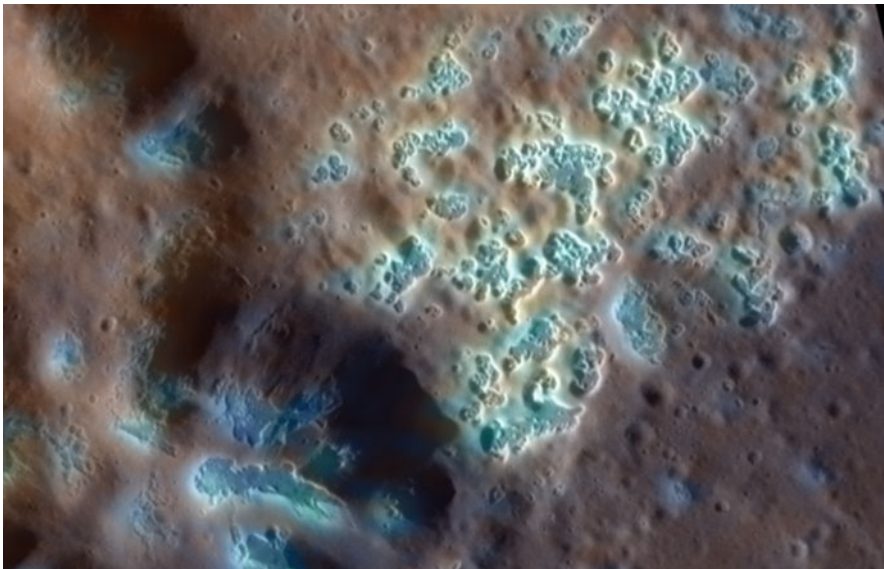


Fig. 2 This is a 18 km wide view of part of the floor and peak-ring structure of Mercury's Raditladi basin. It is a MESSENGER image in enhanced colour. Sunlight is shining from the left (west), casting shadows on the east-facing slopes of the peak ring. Circular, partly shadowed depressions are impact craters. What is most remarkable about the landscape here is the profusion of steep-sided flat-bottomed depressions a few tens of metres deep. These are known in the literature as 'hollows' and have complex outlines. Here, they have formed both on the peak ring and on part of the basin floor through the agency of some unknown process, possibly still active today, that has stripped away the top few tens of metres from Mercury's surface (NASA/Johns Hopkins University Applied Physics Laboratory/Carnegie Institution of Washington)

The hollows in Fig. 2 appear at lower resolution as ‘bright crater floor deposits’, but are revealed in this high-resolution colour image as high-albedo blue material intimately associated with hollowing. While filming for a BBC Sky at Night television programme broadcast in February 2008, Patrick Moore and I mused over the strangeness of these irregular bright patches on crater floors seen on images from MESSENGER’s first flyby. Just about the only thing we got right about them was to agree that more detailed images from orbit would be needed before anyone could work out what they are.

I would probably have written this book anyway, but I would like to record here that in my last conversation with Patrick Moore, in November 2012, less than 3 weeks before he died, Patrick urged me (not for the first time!) to write a book about Mercury. I said that I would if he would promise to write a foreword for it, and so we reached agreement. I know Patrick would have kept his end of the bargain had he been spared.

It is not my intention to present a comprehensive account of the history of Mercury science, though I have traced in broad outline how ideas (and misconceptions!) about Mercury have arisen and progressed. Nor is this a blow-by-blow account of the unfolding of new insights during the MESSENGER mission. Instead, my main aim has been to present a ‘snapshot’ view of Mercury as understood in the year 2014 near the end of MESSENGER’s extended mission in the light of knowledge gained from and ideas spawned by MESSENGER. It will be a decade before a comparable leap forward can be expected thanks to BepiColombo.

Citations

I have chosen not to litter the text with citations. This book is my own distillation (no doubt flawed or unbalanced in places) of what I have learned at conferences, in correspondence, in conversations and on websites, in addition to the peer-reviewed literature.

Citations are, however, included in the credits within figure captions, and in the appendix I give some pointers to finding the most relevant peer-reviewed publications.

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