Lobate Ejecta Deposits in Mercury's South Polar Quadrangle (H15). A. R. Lennox[1] (annie.lennox@open.ac.uk), D. A. Rothery[1], M. Balme[1], S. Conway[2], and J. Wright[3]. [1]School of Physical Sciences, The Open University, Milton Keynes, UK; [2]Nantes Université, Laboratoire de Planétologie et Géosciences, France; [3]European Space Agency, ESAC, Spain.

Introduction: During geological mapping of Mercury's south polar quadrangle (H15), we have discovered unrecorded lobate ejecta deposits, one in particular at Nairne crater (70.36° S, 1.65° E) exhibiting a unique and distinctive morphology. Lobate ejecta deposits are relatively rare on Mercury; Xiao and Komatsu compiled a global database of only 7 craters with ejecta flows [1], and Blance et al. [2] have since found more. However, the timing of emplacement has remains ambiguous. Understanding the formation of the lobate ejecta deposits on Mercury would reveal insights into the factors that control crater morphology, and the characteristics of crater deposits can better our understanding of impact crater formation mechanisms operating on Mercury.

Methods: We mapped using a monochrome basemap (166 m/pixel) in conjunction with individual narrow-angle camera (NAC) images at higher resolutions. Additionally, we used 665 m/pixel enhanced color mosaic and 665 m/pixel digital elevation model (DEM) mosaics to distinguish units by colour and to assist in the mapping of topographic features. All these data are products of the Mercury Surface, Space Environment, Geochemistry and Ranging (MESSENGER) Mercury Dual Imaging System (MDIS) instrument.

Observations: *Morphology.* Nairne crater, from which two ejecta lobes extend, is relatively fresh (c4 [3]) and was formed by an impact onto the rim of a much larger and now significantly more degraded unnamed crater (c1 [3]). It exhibits asymmetrical terracing, a bright blue central peak and bright red impact ejecta. The two distinct lobes that propagate SSW into the floor of the preexisting crater exhibit steep fronts and appear to have greater thickness and surface roughness compared to normal continuous ejecta deposits on Mercury. We also identified very smooth localized deposits perched on topographic lows on top of the larger of the two lobes.

Discussion:

Formation of fluidized ejecta: Key factors affecting the formation of ejecta flows on Mercury include the slope of the underlying terrain, high surface temperature and volatiles [1]. We are currently considering two emplacement scenarios for the Nairne crater: a mass-wasting event producing an ejecta flow similar to that at Tsiolkovskiy crater on the Moon [4], or a fluidised ejecta flow [5]. The morphology of the lobate ejecta deposits is reminiscent of single- or double-layered ejecta craters on Mars. These are thick ejecta with a steep distal margin separated from the near-rim ejecta deposits by a moat [5]. This process has been for Hokusai crater on Mercury, and it has been interpreted as a rampart crater in which the ejecta-fluidising agent was impact melt rather than water, as is the case on Mars [5, 6, 7]. Perhaps similar processes forming Hokusai and this example have led to different morphologies.

Topography. Nairne's ejecta lobes extend into the floor of a preexisting crater. This is highly suggestive of the morphology of the ejecta lobes being topographically controlled. In addition, Nairne's asymmetrical terracing is indicative of three possibilities deserving of further exploration: that the crater formed by an oblique impact, that the impact occurred on uneven topography, or that there was significant target heterogeneity.

Volatiles. Currently, the incidence or role of volatiles in the formation process is unclear. Nonetheless Xiao and Komatsu [1] and Balance [2] provide circumstantial evidence implicating volatiles in the formation process. As such the origin of potential volatiles for this example is being considered. We have observed no hollows associated with Nairne, and consider its location far enough from the pole for it to be unlikely that the pre-existing crater was host to a permanently shadowed, ice-rich region. We have observed lineations projecting from either side of Nairne, highlighted in **Figure 1a**. These are most likely catenae (pitted crater chains), created either by secondary impacts or potentially by the collapse of a lava tube. Though the latter has not definitively been found on Mercury, such a feature would act as conduits for volatile rich lava.

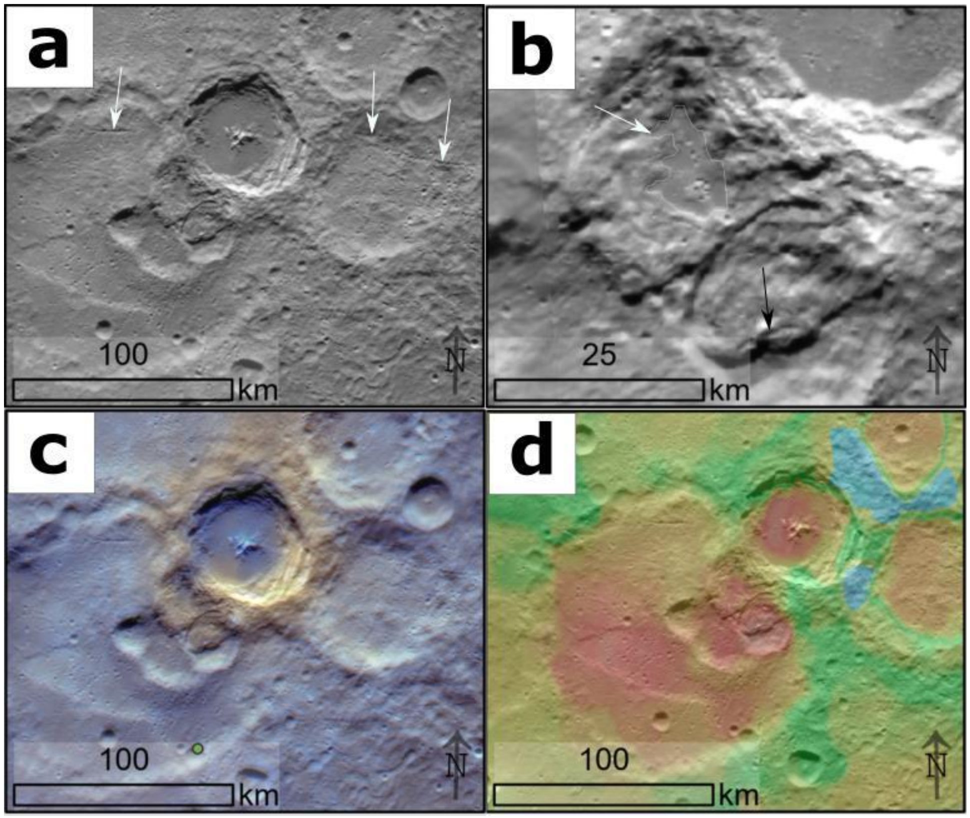

Figure 1: Nairne crater centred at 70.4° S, 1.5° E. **a**) 166 m/pixel basemap with white arrows highlighting potential fissures extending outwards from the crater. **b**) NAC image showing a closer view of the two lobes. White arrow points to perched impact melt, black arrow points to a graben. **c**) 665 m/pixel Enhanced color overlay atop the BDR basemap. **d**) 665 m/pixel DEM of the area showing the pre-existing crater. Red to blue represents low to high elevation.

Timing of formation. Previously there has been no evidence to demonstrate whether ejecta flows on Mercury formed during or after the impact event that formed the crater [1]. We have interpreted the perched smooth patches on the Nairne crater ejecta lobes are impact melt, based on their setting, colour and smooth surface. The impact melt on the lobe and that of the crater floor share a similar blue colour, indicative of a similar composition and may reflect synchronous formation. This provides the first evidence that the ejecta flows occurred early in the impact process.

Preliminary conclusions:

- Our observations corroborate a topographic control on the formation of fluidised ejecta deposits.
- Perched impact melt pooled on top of the larger of the two lobes provides the first evidence for syn-impact formation.

Future work: To better understand this lobate ejecta deposit, we will map the proximal crater facies material, the distal ejecta material, and the secondary craters to better understand the morphology of the main crater. This will be useful for uncovering sequence of events, and the history of impact and formation.

We will also calculate the thicknesses (*h*) and ejecta mobilities (*EM*) to compare these with the database published by Xiao and Komatsu [1], wherein the morphological and geometrical parameters of their 7 candidates are listed. The calculations are: $h = l \times \tan(\theta)$, where l is the estimated length of the shadow and θ the solar angle measured from horizontal, and $EM = L/R$, where L is the ejecta extent and R the crater rim-rim radius [1].

Acknowledgments: The monochrome basemap, enhanced color mosaic and DEM for H15 was downloaded from the Geosciences Node of NASA's Planetary Data System archive. SJC is supported by the French Space Agency CNES. ARL was supported by a UK Science and Technology Facilities Council (STFC) PhD studentship.

References: [1] Z. Xiao and G. Komatsu (2013) *Planet. & Space Sci.* 82-83, 62-78. [2] A. J. Blance et al. (2022) *MExAG Ann. Meeting.* [3] Kinczyk et al. (2020) *Icarus, 341, 113637.* [4] J. M. Boyce et al. (2020) *Icarus, 337,* 113464. [5] J. M. Boyce and P. J. Mouginis-Mark (2006) *J. of Geophs. Res., Planets, 111, E10005.* [6] O. S. Barnouin et al. (2015) *46th LPSC,* 1832, 2670. [7] M. J. Kinczyk et al. (2018) *49th LPSC,* 2083, 2916.